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EDITORIAL ANNOUNCEMENTS

THE BRITISH AND EASTERN CONTINENTS edition of the Railroad Gazette is published each Friday at Queen Anne's Chambers, Westminster, London. It consists of most of the reading pages and all of the advertisement pages of the Railroad Gazette, together with additional British and foreign matter, and is issued under the name Transport and Railroad Gazette.

CONTRIBUTIONS.—Subscribers and others will materially assist in making our news accurate and complete if they will send early information of events which take place under their observation. Discussions of subjects pertaining to all departments of railroad business by men practically acquainted with them are especially desired.

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CONTENTS

The reports of Mr. Van Bogaert and Mr. P. H. Dudley on the subject of Rails for Lines with Fast Trains are very complete, and give a great deal of valuable information in detail, as shown by the abstracts of the papers that we have published during the past few weeks. An excellent opportunity is now offered to get some lasting benefit from these reports, if they are discussed in connection with one or two of the leading rail specifications from each of the countries represented at the International Railway Congress. A general systematic discussion of this kind has never before been undertaken, where existing specifications of the different countries have been made a part of it, and as there is ample time to arrange for such a discussion, it is to be hoped it may be brought about. The specifications could be presented as part of the general discussion, with comment on the points in which they differ from the conclusions of the reporters. We presume that parts of the specifications will be practically the same, but the chemical requirements and physical tests will vary. A general discussion would bring out what is really essential to insist on in order to secure good wearing, reliable rails. This could be done without its being necessary for the congress to adopt a specification; it would only involve a discussion of the most important points in order that the societies working on international specifications might have the advantage of the information brought out. Each country could make use of whatever seemed best suited to its own conditions of manufacture and of service on its roads. In England the standards committee has already adopted a specification for bull-headed rails, and expects shortly to agree upon one for T rails. In this country, the American Railway Engineering and Maintenance of Way Association, and the American Society for Testing Materials have adopted specifications for T rails in which there are only minor differences, and we understand that steps are now being taken to harmonize these differences. Some of the other countries are doing similar work, and this is an indication of the general interest that is being taken in the standardization of rail specifications. The congress will afford the first real opportunity for a comparison and discussion of these specifications.

Mr. Dudley protests against the tendency of designers of modern locomotives and cars to lose sight of the conjoint favorable action of rolling stock and track in reducing the local depressions of the rail to one general depression of the superstructure of the permanent way, and therefore reducing the rolling resistance of the wheels on the rail. He cites the fact that Jervis, by rearranging the wheels and adding a four-wheel leading truck on the "John Bull," one of the first engines run on the Mohawk & Hudson Railroad, greatly improved the riding qualities of the engine and reduced the destructive effect on the track. From an analysis of stremmatograph tests he also shows the comparative effects of modern heavy engines of different wheel arangements and wheel spacing, and emphasizes the necessity of certain relations between the spacing and loads of the wheels on the locomotive and on the tender to produce the most favorable deflections of the track. The value of Mr. Dudley's exhaustive studies and of his elaborate treatise on rails and track is great. But from the standpoint of strictly practical operation, his results are open to the criticism that they are somewhat academic, and unduly magnified in their relation to the ever present problem of doing as well as possible with the resources at hand. The development of the numerous wheel arrangements now in common use from the original eight-wheel or American type of engine of Jervis, has not involved the consideration of the hitherto undetermined deflections of the rails. The maintenance of way department has always been content to lay down only one condition, that of maximum axle load, and the designers of cars and locomotives have been left with a free hand to work out the many other perplexing mechanical problems. When more boiler capacity and a wide fire box were required, it was necessary to add a trailing truck, and when the tractive power demands became greater than could be obtained with the allowable adhesive weight of four pairs of drivers a fifth pair was introduced. The engines and cars were built first, and the maintenance of way department became responsible for building and maintaining a permanent way that would carry them safely. There is no doubt that intelligent co-operation between the designers of locomotives and those who design and maintain the track would result in good, but probably the only improvement which could be made would be a reduction in the rolling resistance of the locomotive, which is the smallest factor of train resistance. The broader problems of locomotive design still demand so much study that the refinements of a perfect harmonization of all parts of the railroad and its equipment, viewed as a single transportation machine, are set far forward into the future.

IS FRICTION DRAFT GEAR A FAD?

Less than two years ago the draft gear question was an all-important one and the advocates of friction draft gear were apparently having the better of the argument. Railroad mechanical officers were eager to find some remedy for the ever-increasing repairs to draft rigging and underframes resulting from the use of heavier engines, high capacity cars and long trains. The makers of friction draft gears claimed for their devices an elastic resistance of from 50,000 lbs. to 100,000 lbs. more than the highest capacity double-spring draft gear then in use and they showed by static compression tests and by drop tests that their claims were based on truth. At that time there were not more than three or four gears which had any real merit, but in less than a year, nearly a hundred patents on friction draft gear were applied for in the first rush of the versatile inventors to get in on the "ground floor" of coming business. Some of these devices were good and some were utterly worthless from practical considerations, but all were ingenious *and* ex-

pensive. Few, if any of these newly patented gears have been applied to cars, largely, perhaps, because the demand for them seems to have almost entirely died out. The specifications for special equipment for the recent large orders of cars show a surprisingly small number of friction gears ordered, in view of the urgent demand for draft gear of higher capacity which existed such a short time ago, and the fact that nearly all the cars ordered are of high capacity, with steel underframes. It is this which prompts the question, is friction draft gear a fad?

There are a number of reasons, possibly, why the agitation of this important question has died out as suddenly as it has. Many of them are purely commercial and result from keen competition; with these we are not concerned, for this side of the proposition resolves itself into a comparison of the saving in cost of repairs to cars resulting from the use of a higher capacity gear and the increased cost of such a gear over an ordinary spring gear. The primary question about which the success or failure of the friction gear hinges is whether or not the principles of mechanics on which all friction draft gears are designed are fallacies and do not hold good under the conditions of actual service, although they may be manifest in observing the action of such gears under static and drop tests. We have held from the beginning that the principle of the application of friction in the moving parts of a draft gear to assist in absorbing the shock was a logical, simple and correct one and that there was a need of an increase in the elastic resistance of draft gears under the increasingly severe conditions of modern train service if the damage to cars and lading from excessive shocks was not to reach an exorbitant figure. If, as is claimed by some, friction draft gears do not absorb and dissipate at least a part of the energy of the blow when two cars come together but act only as an inefficient spring gear, then we are wrong in the position which we have taken. But we are not yet ready to admit that such is the case.

The comparative draft gear tests made under the drop testing machine at Altoona in 1902, by a committee of the Master Car Builders' Association, showed conclusively that the friction gears as a class had a higher elastic limit, greater ultimate strength and less maximum height of rebound of the tup than the spring gears which were tested at the same time. The static tests under compression in a screw testing machine which were reported at the same time were even more conclusive evidence that friction draft gear does absorb and dissipate energy. Neither of these tests, however, represents the actual service conditions which influence the action of a friction draft gear under a car when it receives a blow such as is given in switching or bucking a long train out of a sag by taking up slack. The drop test represents the most unfavorable condition and the static test the most favorable condition for comparison. Actual service conditions lie somewhere between these two. The drop test is conducted with a light mass (1,640 lbs.) striking at a high velocity. In the static test the friction surfaces move slowly and gradually over one another with the maximum of adhesion and efficiency. In a spring gear, aside from the small amount of friction between the moving parts which is always present under any movement, quick or slow, the only dissipation of energy is the small internal friction in the metal in the spring which is also nearly constant in amount under the drop test or static test.

The value of the drop test in comparing draft gears of the same or different types is open to very serious question. For testing car wheels, couplers or axles it can be considered only as a means of approximately determining the comparative strength of the material in the several specimens tested and not as a final indication of the strength of different designs of these car parts under actual service conditions. It is a substitute at best and in the case of draft gear tests in which the principles of impact affect the action of the specimen under test it will give results that are often misleading and useless even for comparison.

The nature of the blow delivered by a light drop weight striking at high velocity is very different from the nature of the blow when two heavy cars moving at a low velocity come together even though the kinetic energy in both cases is the same. Assume that the drop weight of 1,640 lbs. falls from a height such that the energy of the blow will be just sufficient to close the gear under test down solid. Assume, also, a loaded car weighing 150,000 lbs. moving at a velocity such that its kinetic energy is the same as that of the drop weight. The draft gear in both cases will be just closed solid. Now it can be shown mathematically that the time necessary to absorb the energy of moving masses in impact having the same kinetic energy but different velocities varies directly as the square root of the masses. In the assumed case, therefore, the time necessary to close the draft gear solid under a loaded car is to the time necessary to close under the drop weight as $\sqrt{150{,}000}$ is to $\sqrt{1{,}640}$ or nearly ten times as long for exactly the same travel of the moving parts. The static tests of friction draft gears prove conclusively that the maximum efficiency is obtained when the friction surfaces are moved slowly and steadily over one another. The drop tests show the friction gear to be more efficient than the spring gear even under the most unfavorable conditions. Is it not therefore, reasonable to conclude that under service conditions where the parts move over one another only one-tenth as fast as under the drop, the efficiency of the friction gear will be even more pronounced?

As to the necessity of applying more elastic resistance under modern heavy cars than can be obtained with two M.C.B. class H. draft gear springs with a combined capacity of 38,000 lbs., we see no reason now to recede from the position taken some years ago. The Westinghouse dynamometer tests on the Lake Shore showed the magnitude of the shocks to which cars are subjected in ordinary service to be as high as ten times the capacity of a double spring gear and any device which will absorb even a small part of these excessive shocks is to be commended. Within the last year or so, there have been applied to a number of cars, spring gears with two M.C.B. class G, triple-coil springs having a total capacity of 60,000 lbs. This is plain evidence of the demand for higher draft gear capacity. Without the improvements in the design and material of couplers such a gear would be more destructive than protective, but the steel couplers as now made with the new contour lines and solid knuckles can resist tremendous shocks of recoil without damage. It is an open question, however, whether the draft gear attachments can stand the strain, and such a gear certainly cannot cost much less than an expensive friction gear with higher capacity and little or no recoil.

The draft gear question is just as much alive to-day as it ever was, in spite of the seeming apathy. Perhaps more convincing proof is needed than has yet been presented to overcome the conservatism which exists. What is needed is a comparative test under actual service conditions. It would be highly interesting and instructive to take four cars in as nearly the same condition as possible and equip two of them with friction draft gear and the other two with spring gears. Run one of the cars equipped with spring gears into the other car with the same type of rigging at a number of speeds from one to ten miles an hour and measure the distance between the cars when they came to rest. Repeat the experiment with the cars equipped with friction gears and then with one car with friction gear and one car with spring gear. The distance between the two cars when they came to rest would be a fairly accurate measure of the force with which they were separated and since the energy with which the cars came together would be equal in each case it would also be an indication of the amount of energy dissipated by the two types of gears. Such a test would settle the controversy definitely.

MR. KNAPP ON RATE REGULATION.

Hon. Martin A. Knapp, Chairman of the Interstate Commerce Commission, presented a paper recently before the American Economic Association on the regulation of railroad rates, and in a full and temperate discussion gave perhaps as good a statement of his side of the case as any that has yet been made. This paper will be found in full in another column. Mr. Knapp holds that the transfer of land commerce from ordinary highways to railroads has not impaired the right possessed by all persons to make common use, involving a certain proprietorship, of the best available means of transportation; that such right has always existed in the past and still exists unimpaired. This is a rather serious fallacy, being historically incorrect as regards the freedom of highways in the days of the barons and making no distinction (if meant to apply to our own country) between highways built by the commonwealth and railroads built by private capital. Mr. Knapp's general point of view is far removed from being socialistic, but it seems necessary at the very outset to call attention to this confusion of private property with public property, for it stands at the bottom of a great many false arguments made by writers less conservative than Mr. Knapp. If the commonwealth buys land to create a park, it can make it a public park. If it builds a railroad it can declare that railroad to be a public highway; but if railroads are built by private capital, according to the

prevalent method in this country, the commonwealth cannot declare them public highways in the sense evidently meant by Mr. Knapp. When he says that the railroads are an agency of the state for discharging a public duty and that the right to use their facilities, like the right to the common highway, is an inherent and inalienable right, the very essence of which is equality, he forgets that in the form of the taxes which they pay they make recompense to the state, while they receive no countervailing support from the state to pay for what he calls their agency. Like all taxpayers the railroads are subject to a kind of police control by the state, but it is certainly inaccurate to say that they are its agents.

Mr. Knapp goes on to point out the evils of rebates, discriminations, rate cutting, and the like, and mentions that an administrative body like the present Interstate Commerce Commission is wholly without authority to prevent this, and he asks if railroad managers themselves are to be the sole judges of the reasonableness of their own rates. Not to insist unduly on the first argument, we should reply that as representatives of the persons who built and equipped the railroads, and who are paying taxes to the state, they might well be expected to take a direct interest in the way their property is managed. A railroad which is a private commercial venture has but one direct source of earnings, and that arises from its rates. Consequently, when Mr. Knapp says that to investigate tariffs, made for the most part by the railroads themselves and in their own interest; to compel their correction when found to be oppressive or unfair, and to determine in such cases what are just and reasonable rates for public carriage—that all this is a governmental function of the highest utility; that it is the central idea of regulation and the permanent field of its usefulness—the obvious reply is, by what right? With fullest understanding of the importance of state police power, as it may be called, to carry out the legal maxim that the rights of an individual or corporation should be so used as not to damage others, the obvious answer to those who take the line of argument propounded by Mr. Knapp is that the government did not build the railroads in this country and does not own them. On the contrary, in the early days of national development, when there was most vital and pressing need for communication, the government and the individual states alike were entirely ready to allow private capital to perform this work for them, understanding well that while the private capital invested was earning dividends the development of the country would take place, and that the one must proceed hand in hand with the other.

Mr. Knapp would give pooling to the railroads, or, at least, permit legalized agreements between railroad companies, at the same time that he conferred the rate-making powers on Congress through its agent, the Interstate Commerce Commission. While the old fallacy of a law which would at once prevent discrimination and make agreements between railroads impossible has often been pointed out, it must be frankly said that the question of legalized agreements is not one of pressing moment at the present time, for it has been found practicable for many years to operate on the kind of agreement which cannot be found when searched for, nor can it be proved to exist, but which serves fairly well, at a time when traffic conditions are tolerably settled. It would seem scarcely necessary, for example, that the mutual understanding as to rates and running time on the roads connecting Chicago and St. Paul should be legalized. Mr. Knapp sees plainly and expresses clearly the troubles and disadvantages attendant upon the unrestrained competition which the Government specifically requires at the present time. Yet he does not see that in removing the apparent necessity for such competition by permitting agreements between roads he would change very little the actual working arrangements, while his proposed rate-making law would be far more restrictive and economically wrong (entirely apart from its aspect in connection with the danger of extending Federal control) than the anti-pooling law ever was or could have been.

Summary of Traffic Tendencies, Railroads Reporting June 30.

The plan was tried last year at this time of printing in the *Railroad Gazette* a general summary of the results of the year's operation on some 50 railroads which reported for a fiscal year ending June 30. The method followed was to show graphically the course of gross earnings, net earnings and operating expenses by means of diagrams and to supplement these diagrams with sufficient other statistical information so that the striking operating features of the year as shown in the working of the largest railroads could be grasped at a glance. It was thought that such a record would not only possess current interest but would be of considerable value historically if continued year by year.

The first diagram of the present paper, continuing this series, shows the respective curves of gross earnings, operating expenses, and net earnings from June 30, 1899, to June 30, 1904. The following railroads are represented: Atchison, Topeka & Santa Fe; Great Northern; Baltimore & Ohio; Illinois Central; Chesapeake & Ohio; Louisville & Nashville; Chicago, Burlington & Quincy; New York, New Haven & Hartford; Chicago, Milwaukee & St. Paul; Norfolk & Western; Cleveland, Cincinnati, Chicago & St. Louis; Philadelphia & Reading; Chicago & North Western; Southern; Northern Pacific; Wabash; Erie. The selection was intended to embrace characteristic roads in all parts of the country which had not materially changed their physical status in the last five years. The diagram is self-explanatory and shows clearly the fight which was made all last winter and spring against the increases in operating expenses due to higher cost of fuel, higher wages, and also, in no inconsiderable degree, to the severity of the winter.

The one feature which stands out most prominently in a review of the 50 or so reports at hand is this struggle to reduce operating expenses. The following table analyzes the component parts of operating cost and gives the totals of each of the important items in 1904, as compared with 1903. The list of railroads from which these returns are compiled is substantially the same as that previously given;* but it has been possible to add several large properties which, owing to physical changes, were not available for a five years' comparison.

19 roads.	Conducting transportation.	Maintenance way and structures.	Maintenance of equipment.
1904.....	$294,562,734	$103,287,151	$91,205,145
1903.....	267,923,355	104,580,211	90,851,271
Inc. or dec..	Inc. 9 9/10%	Dec. 1 1/5%	Inc. 4/10%

This table shows that the general head of conducting transportation included the expense items most difficult to reduce. Maintenance of equipment was kept down to practically the same figure as last year, while the charge for maintenance of way and structures was actually reduced.

When reductions are reported in the maintenance account, the important thing to know is whether the saving was effected by the reduction of work of a more or less extraordinary character which was being charged to that account as a matter of convenience, or as part of the company's policy in making permanent betterments out of earnings, or whether an insufficient amount was spent on the up-keep of the property. With the great majority of the roads under review this saving was evidently made under the first head. The properties were fully maintained, but all unnecessary work was put off for a better season. But one or two roads were criticized by the *Railroad Gazette* at the time that their individual reports were reviewed because the maintenance appropriations were too small. This was particularly true of the Chicago, Milwaukee & St. Paul, where the equipment maintenance for the current year figured out only to $1,493 per locomotive, $531 per passenger car, and $38 per freight car.

The next table shows the freight earnings and the passenger earnings of 21 roads in 1904 as compared with 1903, and illustrates an interesting tendency of the last few years which was especially noticeable in a dull season.

21 roads.	1904.	1903.	Inc.
Freight earnings...	$547,894,378	$522,963,126	4%
Passenger earnings.	210,813,060	198,180,426	6%

In spite of the large area covered by the roads under review, which tends to neutralize temporary stimulations of traffic like the World's Fair, it will be seen that with freight increases of 4 per cent. passenger traffic increased 6 per cent. during the year. This tendency has been becoming more and more noticeable with each succeeding season during the past two or three years, and illustrates a fact which is often overlooked; that with the growth of the country in general and with the up-building of any specific locality, there is going to be room for a great many years for a very rapid increase in passenger business. To take a single illustration of a railroad in a rapidly growing section of the country, the following table of passenger earnings on the Atchison since 1897 is quite remarkable:

Atchison, Topeka & Santa Fe Passenger Earnings.			
1897.....	$5,574,288	1901.....	$11,678,017
1898.....	7,347,361	1902.....	13,439,384
1899.....	8,126,141	1903.....	13,469,985
1900.....	9,334,661	1904.....	15,433,773

Through good times and bad the passenger earnings in eight years increased from 5½ millions to nearly 15½ millions, 176 per cent.; while freight earnings during the same period went from $22,067,686 to $47,762,653, an increase of 116 per cent.

Fig. 2 shows the percentages in gross earnings, operating expenses and net earnings of 101 roads for the ten months ending Oct. 31, 1903. Fig. 3 shows the same calculation for 95 roads for the same ten months of 1904. For the collection of railroad statements from which the diagram was prepared we are indebted to the *Commercial and Financial Chronicle.* These diagrams are particularly graphic, for the reason that the gains in gross earnings were very considerable in November and December, and a diagram ending with October makes about as unfavorable a showing as could be made through an extended series of months.

*Buffalo, Rochester & Pittsburg; Chesapeake & Ohio; Denver & Rio Grande; Chicago & North-Western; New York, New Haven & Hartford; New York Central; Illinois Central; Norfolk & Western; Missouri, Kansas & Texas; Chicago & Alton; Cleveland, Cincinnati, Chicago & St. Louis; Wabash; Rock Island; Chicago, Milwaukee & St. Paul; Atchison; Baltimore & Ohio; Burlington; Southern Pacific; Great Northern.

These diagrams need no explanation. It was predicted in the corresponding statement last January that it was quite possible that 1904 would show the seeming anomaly of decreased gross earnings with considerable accompanying increases of net. This state of affairs was to be found on a number of the largest roads until well along in the fall; as for example, on the Pennsylvania. From Dec. 31, 1899, to Dec. 31, 1902, gross earnings increased 54 per cent. and net earnings 66 per cent.; but while gross earnings on the entire system increased $18,629,800 in the year ended Dec. 31, 1903, operating expenses increased $18,988,300, leaving net earnings $358,500 less than they were the year previous. Then the campaign against operating expenses was begun, and in June, 1904, an increase of $440,300 in net was reported in a month when the gross increase was only $76,000. Later on in the summer there were decreases in gross accompanied by excellent net gains. One obvious reason why the Pennsylvania and some other of the larger roads were able to curtail expenses so readily was the extremely large amount of extraordinary work which they had outstanding; work which was being charged against income so far as it was possible to do so and which could feasibly be held over until a better year.

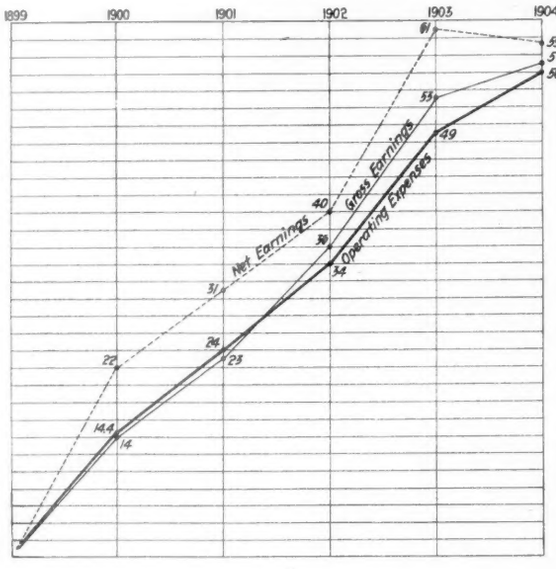


Fig. 1—Percentages of Increase over 1899; 17 Roads.

The following table compares train loads for the last four years on 17 roads which represent practically all parts of the country. The figures exclude company's freight, except in one or two instances where no separation was made in the railroad statistics. It was not to have been expected in a year of retrenchment that any great gains would be made in train loading, but it will be seen that the general trend has been upward in spite of a few decreases. The average of the entire number was 357 tons as against 354 in 1903, 335 in 1902, and 313 in 1901. The value of the train load figure as an index of operating efficiency is chiefly confined to comparisons through a series of years of the same property or to comparisons of two or more properties that are strikingly alike in their physical condition; for it is obvious that a number of circumstances, as, for example, a greater or smaller proportion of branch line mileage, would affect the result disproportionately. For example, the average train load for the main line of the Minneapolis, St. Paul & Sault Ste. Marie was 335 tons in 1904, while the average train load for the system, including branches, was only 305.

Revenue Train-Loads; Tons.

	1904.	1903.	1902.	1901.
Atch., Top. & Santa Fe.	269	279	247	242
Baltimore & Ohio	416	401	406	381
Buf., Roch. & Pittsburg.	439	441	424	406
Chesapeake & Ohio	508	493	508	511
Chicago & Alton	336	356	316	288
Chic., Bur. & Quincy	278	266	218	201
Chic., Mil. & St. Paul	245	244	254	236
Erie	400	406	376	375
Great Northern	447	446	417	381
Illinois Central	289	277	275	235
Lehigh Valley	486	485	467	467
Minn., St. Paul & S. S. M.	305	300	315	314
Northern Pacific	326	339	346	324
St. Louis & San Francisco	200	195	187	200
St. Louis Southwestern.	388	384	344	318
Union Pacific	451	403	418	365
Wabash	286	302	285	283
Average, 17 roads	357	354	341	325

Pennsylvania-New Haven Forecast.

The entry of President A. J. Cassatt, of the Pennsylvania Railroad Company, into the directorate of the New York, New Haven & Hartford corporation, has more meanings than one. Some of those meanings are immediate and positive in their bearings, others are symptomatic, remote and in the nature of forecast.

The first in the sequence of causes of the step takes us back to the acquisition of the Poughkeepsie Bridge system as one of the earliest strokes of President Mellen after he assumed the presidency of the New Haven Company. It can now be seen, more clearly than it could be seen then, that the taking of the Poughkeepsie Bridge lines created a sub-acute situation in the relations of the New Haven to the connected trunk lines; for the new route, to fulfil President Mellen's large plan, had to get new business, partly western and partly coal traffic, particularly the latter. To make a somewhat long story as short as possible, President Mellen at first sought either control or a large interest in the Lehigh & Hudson as a kind of "belt" line tapping the large coal roads, but was thwarted by the action of the coal road presidents; and about the same time, the New Haven management became suspicious of a scheme of the connecting companies to enforce, if possible, such a readjustment in the division of freight charges, particularly on coal, as would impair considerably the New Haven's revenues. Just about that time, also, came the deferred option on the Ontario & Western, accepted and, several months later, taken up. It armed President Mellen with two "big sticks," one reaching out over the anthracite coal fields, the other raised threateningly toward the west from Oswego; and it not only "jarred" the trunk and coal combination pretty seriously, but also created a shaky situation.

It is, undoubtedly, to promote the imperilled harmonies that President Cassatt now enters the New Haven Board. But there are other grounds less of an opportunist nature. For one thing, the Pennsylvania has for years been the New Haven's most important connection in exchange of through freight traffic. It was stated officially some two years ago that, of that traffic, the Pennsylvania handled 50 per cent.—reduced later to about 35 per cent. with the acquisition of the Poughkeepsie Bridge system, but probably, of late, moving back toward its old

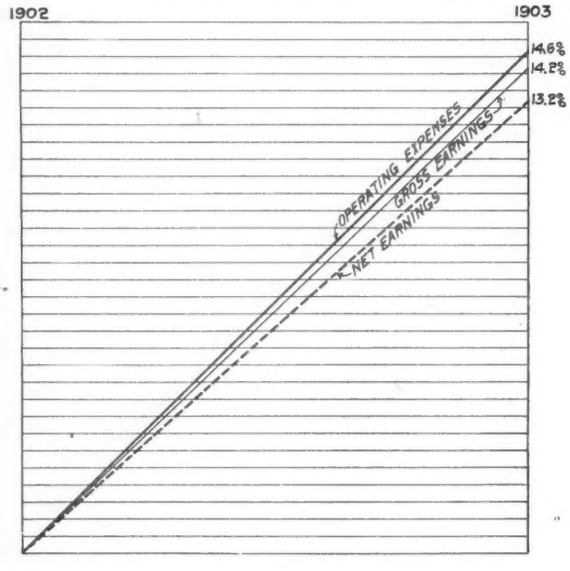


Fig. 2—Percentages of Increase, 10 Months Ending Oct. 31, 1903; 101 Roads.

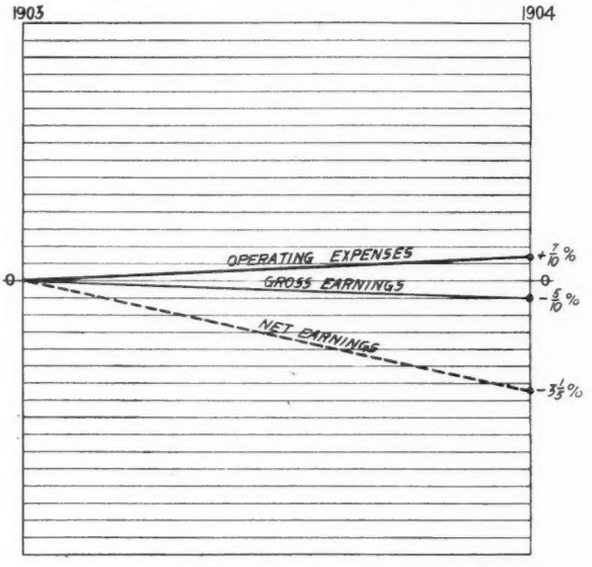


Fig. 3—Percentages of Changes, 10 Months Ending Oct. 31, 1904; 95 Roads.

ratio. With so large a connecting interest it seems strange indeed that Pennsylvania representation in the New Haven board should have been so long deferred. But we leave that branch of the subject to consider the more interesting, if less definite matter of the ultimates which the new condition forecasts.

It is probably stated correctly in a Philadelphia despatch that President Cassatt on entering the New Haven board will take up in the Pennsylvania interest a block of about 10,000 shares of New Haven treasury stock. This is a trifle as compared with the 800,000 shares outstanding but it is an entering wedge and, in fact, is either the second or third largest si..gle New Haven stock holding. The combination of New York Central direct and indirect holdings, however, much exceed it. Recently the New York Central block was 5,500 shares, and it is probably the same now, to which, if Vanderbilt and Rockefeller stock is added, the total would be nearly 20,000 shares represented in the New Haven board by at least two directors and, perhaps, by one more. That with such a disparity, there will be a tendency hereafter at least to "even up" the holdings and representation of the two interests is obvious enough, but what that may lead to is speculative surmise. One thing, however, is all but sure: There can hardly be buying for "New Haven control." That "old maid's stock," so called, is remarkably distributed. A few years ago the 25 largest holders had but one-eighth of the shares; there has been some concentration since, but it is well nigh certain that the 25 largest holders have not more than one-sixth. The next sixth would probably include 100 holdings, the third sixth 1,000 more, and any attempt to buy control would send the stock kiting to the unreachable zenith of prices. If the New Haven control, therefore, ever passes to an outside interest it must presumptively be by lease, not by purchase, or exchange of shares.

A second interesting element in any forecast is the charter provision of the New Haven Company by which a majority of the directors must be residents of Connecticut. There is thus created a localized control which, to be sure, might be nullified by the old device of residential "dummy" directors, but which, with the present intense Connecticut feeling, both inside and outside the board in favor of the genuine localized control, becomes a very stalwart obstacle to any transfer. Meanwhile, however, we are witnessing a steady diminution of the actual Connecticut holdings. Even so late as 1898 in that state there were but 2,624 holders of 123,630 shares as compared with 5,884 outside holders of 380,740 shares. Since then about 300,000 additional shares have been issued and, with nearly or quite 14,000 stockholders now, it is doubtful whether 20 per cent. of the shares are held in Connecticut; and the ratio constantly decreases. Under such conditions it is logical that the present fact, as well as the theory of narrow local control of a great corporation must weaken, and, sooner or later, pass away.

There are other questions which the entry of President Cassatt into the New Haven directorate raises, all bearing on the railroad situation in southern New England, and its outside business. What, for example, will be his influence as a personality in the board? Will he succeed in so far modifying Mr. Mellen's great plan of developing Poughkeepsie Bridge traffic that it will not militate against the Pennsylvania freight connection via the proposed Brooklyn loop? In that future absorption of the New Haven system, which sooner or later seems predestined under the inexorable law of consolidation, will the Pennsylvania and New York Central work as rivals or in harmony —perchance taking over the New Haven as joint lessees? These are, doubtless, questions of years, not of months. But, in the forecast, it cannot be denied that the new directorship of President Cassatt suggests them.

NEW PUBLICATIONS.

Illinois Railway Legislation and Commission Control Since 1870. By J. H. Gordon, A. M., Urbana, Ill.: The University of Illinois, 81 pages. Price 25 cents.

The Granger Movement in Illinois. By A. E. Paine, A. M., Urbana, Ill.: The University of Illinois, 53 pages. Price 35 cents.

Two monographs on the general subject to which the attention of the public has lately been directed by President Roosevelt, have recently been published by the University of Illinois. Mr. Gordon, author of the first monograph, was formerly a member of the University faculty. Mr. Paine, author of the second, is on the staff of the Peoria, Ill., *News*. Mr. Gordon's work has an introduction by Professor M. B. Hammond, then of the Department of Economics of the University, covering that subject before 1870.

Mr. Gordon gives a description of the railroad situation in the state in 1870, and then recites the constitutional provisions concerning railroads, following with a narration of the restrictive legislation of 1871 and the work of the first railroad commission. He devotes one section to the history of the litigation over the enforcement of the law, next discussing the law of 1873 and the powers conferred upon the commission. The history of the legal struggle in the courts is given, as is also the story of the legislative amendments to the acts and the later work of the railroad commission. The author concludes that the "work of the commission has justified its establishment . . . and that it still does a work of positive value to the state." He commends the recommendation of the commissioners, made some years ago, to extend the term of office to six years, with one member retiring every two years. He advises that the power of the commission should be extended over sleeping car and express companies, and that the commission be given authority to require reports from telegraph, telephone, and street car companies.

The second pamphlet, which is No. 8 of the University studies, gives an excellent history of the Granger movement in the State of Illinois. The first part of the article gives a brief history of the rise of the National Grange and the spread of the Granger movement. The History of the Illinois Grange is then taken up and its organization and growth traced from the formation of the first grange, in 1868, down to April of the present year. Grange legislation in Illinois is reviewed under the subject of "The Grange and the Railroads," and the influence of the Grange upon readjustment of railroad rates is pointed out.

Ordinary Foundations and the Coffer-Dam Process for Piers. By Charles Evan Fowler, C. E. New York: John Wiley & Sons. 1905. Cloth, 314 pages. Price $3.50.

Part of this book was first published in 1898 under the title "Coffer-Dam Process for Piers." The author has added additional chapters on ordinary foundations, use of metal cylinders for piers, bearing capacity of soils and building stone, masonry and design of piers. The large and important examples of foundations have been covered in the technical press with great thoroughness to the exclusion of the more common but none the less interesting methods used in ordinary foundations. In this book the whole subject has been covered without devoting undue space to any one example or method of construction, making it of value to the practicing engineer who is constantly encountering many problems in the construction of the smaller works about which little or nothing is said. The book might equally well be used as a text-boox for instruction.

The "Mechanical World" Pocket Diary and Year Book. Eighteenth year. Manchester: The Mechanical World. Cloth. Price 6d.

This is an English publication very similar in many respects to the numerous other engineering pocket hand books. It contains this year much new matter in the shape of tables and formulæ and the remainder of the book has been carefully revised. In addition to the printed pages a complete diary for 1905 is bound in the back with blank pages for notes and memoranda.

TRADE CATALOGUES.

Steam Shovel Magazine.—The Vulcan Iron Works Company, Toledo, Ohio, has begun the issue of a quarterly magazine entitled "Steam Shovel News," its purpose being to interest a greater number of people in labor-saving excavating and dredging machinery. The initial number has an appropriate cover design in colors and the presswork and engravings are good. Although devoted primarily to steam shovels and their work, other interesting matter is included.

Pneumatic Tools.—The Philadelphia Pneumatic Tool Company, Philadelphia, Pa., sends its catalogue of special pneumatic appliances for marine work. It is illustrated throughout with half-tones which show the different devices in operation and the method of attaching them to the Keller pneumatic drills and hammers. The pneumatic deck-caulking machine shown is a unique tool and is operated by a Keller pneumatic hammer mounted on wheels.

Forging and Special Machinery.—Williams, White & Co., Moline, Ill., maker of special machinery, sends its catalogue No. 6. Illustrations and general descriptions of bulldozers, board drop hammers, crank drop hammers, Yeakley vacuum hammers, eye bending machines, tie cutting machines, punching and shearing machines, gang boring machines, multiple punches, tire welders, benders, etc., are given.

Air Compressors.—The Ingersoll-Sergeant Drill Company, New York, sends the advance sheets of its catalogue No. 36. Several views of some of the important compressor installations made by this company are shown, including those of the Cleveland Stone Company and the Mare Island Navy Yard. A brief description of air receivers, inter and after coolers, is also given.

Vestibule Diaphragm.—An eight-page pamphlet of the Railway Appliances Co., Chicago, describes the "R. A." or "Ajax" cotton belting diaphragm. Its construction is shown by detailed drawings and explained in the text. Drawings of the "R. A." vestibule curtain bracket and roller curtain are also shown and its advantages briefly noted.

Steel Ties.—The Avery Stamping Company, Cleveland, Ohio, sends an illustrated folder descriptive of the Avery steel tie.

Cable Grease.—A. Stalknecht, Saginaw, Mich., sends information about his U. S. A.

cable grease, printed on a triple card-catalogue form. The grease lubricates and waterproofs cables, and information is given as to what it is, when to use it, and how much to use.

Engagement Book.—Vest-pocket size engagement books for 1905 are sent out by The Vulcan Iron Works Company, Toledo, Ohio. The book also contains the Diamond atlas of the United States, pages for cash account, addresses, memoranda, etc., and miscellaneous useful information.

Valves.—The Hancock Inspirator Company, New York, sends its catalogue of angle valves, globe valves and cross valves. A detailed description of these valves, including illustrations, is given, as well as the prices of the different sizes and their parts.

Electric Hoists.—The General Pneumatic Tool Co., Montour Falls, N. Y., sends its bulletin No. 56, in which detailed descriptions and illustrations of both traveling electric hoists and electric hoists of the jib and derrick type are given.

Graphite.—Joseph Dixon Crucible Co., Jersey City, N. J., sends its January number of "Graphite." It is a special issue devoted to lubrication, and it contains a number of articles and illustrations of interest to those who have to do with the above subject.

CONTRIBUTIONS

Technical Schools Versus Technical Faculties.

Boston, Dec. 17, 1904.

TO THE EDITOR OF THE RAILROAD GAZETTE:

Sir: In connection with the proposed combination of the Massachusetts Institute of Technology with Harvard University the following authoritative statement of foreign opinion (translated from *Zeitschrift des Vereines deutscher Ingenieure* of Sept. 24, 1904) is of interest:

"At a meeting of the Union of German Engineers, held at Munich, September 12, with the participation of 30 eminent representatives of technological schools and universities, as well as of other schools and of industries, the following resolutions were adopted:

"1. It is not advisable, so far as can be foreseen, to attempt to meet the need of new technological schools by the addition of technological faculties to universities, but rather by the establishment of independent institutions; for the technological schools would be hindered in their independent development by attaching them to universities. This separation should not, however, impede the welcome development of intellectual good will between the two institutions. The attachment to universities would also in no way involve economies of consequence.

"2. The Union of German Engineers stands now, as before, by its expression of 1886, as follows: 'We declare that the German engineers have the same needs and will be subjected to the same judgment as to their general culture as the representatives of other professions based on higher scientific education.'

"In this view we rejoice as the conviction more and more gains ground that a considerably greater significance is to be attributed than before to mathematical and natural science as a means of culture. Knowledge of these branches is becoming more and more an indispensable constituent of general education. The predominantly linguistic education now received by the majority of our gymnasium graduates does not satisfy the demands which must be made on the leading classes of our people, in particular, in respect to the increasing significance of economic questions."

TECH GRADUATE.

The Lake Shore Class K Locomotives.

TO THE EDITOR OF THE RAILROAD GAZETTE:

In looking over the issue of Dec. 2 I was much pleased with the illustrations and description of the new class K engines built for the Lake Shore. These engines are particularly interesting in that they are built for *passenger service*, and it is indeed refreshing in these times of 10-wheel and 4-6-2 types to find that some one can design and run a *heavy passenger engine*, and can keep it on the rails without the old fogy four-wheel truck to steer it around curves and carry a large amount of weight that might be useful for tractive power. It will be seen that the driving axle loads on this engine are not excessive, 55,333 lbs. on a 9½-in. x 12-in. journal, which is but 494 lbs. per sq. in. The wheel base is not very long for a wheel of the diameter used on this engine.

The description does not state whether the main wheels are flanged, but I take it for granted that this excellent design has not been spoiled by this barbarous practice, which I note is being done in case of many of the six-coupled types of late. It is also interesting to note the high adhesion of this engine (5.96), which should make it a good engine to stand up under unfavorable conditions, a feature that will be appreciated by practical railroad men the world over.

The description does not state who is the designer of this splendid machine, but I should deem it a pleasure to personally extend my congratulations to him who has the courage to get out of the rut and give to the railroad world such a handsome, business like engine.

J. V. N. CHENEY.

Rails for Lines With Fast Trains.*

BY P. H. DUDLEY.

(*Continued from page 11.*)

The second chapter of the report takes up the increased operating efficiency realized with heavier rails and substantial ballast and foundations. From the replies received and the author's own wide experience it would seem that the "combined stability" of track laid with heavy rails and good foundations has increased rather more than 100 per cent. for fast passenger trains and for heavy fast freight trains a gain of from 200 to 500 per cent. is shown. By "combined stability" is meant the combined running stability, efficiency and capacity for thousands of repetitions of stress between engines, cars and permanent way. It is an abstruse term and not easily understood so that most of the replies received were approximate guesses only.

In reply to the question as to the effect on the track of eight-wheel, ten-wheel and Atlantic type engines hauling fast passenger trains, the Burlington says "it finds that the high speeds which have been obtained during the past ten years as compared with the preceding decade are more severe on the permanent way. It cannot say that there is much difference in effect as between the different types of engines except as measured by their weight. The excess weight in engine counterbalances, put in to offset reciprocating parts, has a very appreciable effect in vertical and lateral bending of the rails whose section is not rigid enough for the requirements. It also affects the line and surface on track with heavier rails where the rail itself is not deformed."

The additional coefficient of friction realized on the heavier, stiffer rails is an important factor. Most of the replies to the question as to the coefficient of adhesion on heavy rails range from 20 to 25 per cent. of the weight on drivers. The Pennsylvania reports 23.8 per cent. realized at the drawbar, equivalent to at least 24 per cent. under the drivers. The author has noticed a decided difference in the adhesion of the wheels of a locomotive when running over good, smooth track with joints well maintained, and when running on track with low joints. When reaching a stretch of poor track, one driving wheel loses its adhesion for an instant on passing over a low joint and all of the wheels will commence to slip. An instance of the increased adhesion of the wheels on heavy rails is shown by the reply of the New York, New Haven & Hartford, which has 100-lb. rails and well maintained joints. This states that 23 per cent. of the weight on drivers is realized for adhesion in passenger service and 27 per cent. in freight service.

As to the engine slipping more at high speed than at low speed, letters were sent to all of the enginemen who run the Empire State Express and the Twentieth Century Limited on the New York Central. They all replied that they were unable to detect any increased tendency of slipping of the drivers at high speeds above 60 miles an hour. One engineman said: "We are so sensitive to every running movement of the locomotive that a partial slipping of the wheels per revolution would be instantly felt." Reports from enginemen running fast trains on other roads confirm this statement. Electric motors mounted on independent axles, because of their uniform torque, realize a greater percentage of adhesion than a steam locomotive. Grades of 8 and 10 per cent. are operated with electric motors without difficulty. Four-cylinder balanced compound locomotives because of their uniform torque should increase the coefficient of adhesion somewhat.

For freight service the consolidation (2-8-0) type of locomotive has come to be the usual design on American railroads. In reply to the question of what type of locomotive showed the greatest combined adhesion and stability with heavy rails in fast heavy freight service, 19 roads replied consolidation (2-8-0), nine replied 10-wheel (4-6-0), and four replied mogul (2-6-0).

Chapter III of the report deals with the nature of the superstructure under heavy rails and its relation to the stability of the permanent way. Observations made at the Grand Central Station showed that with 4½-in., 65-lb. rail, 5⅛-in., 80-lb. rail, and 6-in., 100-lb. rail, the tonnage carried before surfacing was required, on the inbound tracks was in proportion to the cube of the moment of inertia of the sections. The volume of traffic is great, about 2,500,000 tons a month, and similar results could not be expected where the traffic is lighter. On the outbound tracks, where the maximum expenditure of tractive effort is required to start the trains, the gain was much less. On the main line the comparison between the 65-lb. and 80-lb. rails showed that the tonnage carried before surfacing was required was more than doubled. The weight of the superstructure is undoubtedly an important factor in the stability of the permanent way.

The principal value of treated ties and improved rail fastenings is in increasing the durability of the track, and therefore its

*Abstract of a report to be presented to the International Railway Congress, May, 1905.

stability, because the removal of decayed ties would be made at longer intervals and the track would not be subjected so often to a general disturbance. An efficient rail fastening would reduce the movement of the rails on the ties and therefore the movement of the ties in the ballast. Heavy ballast is necessary under good track to load the foundation favorably. As regards the cutting out of the ties less rapidly under heavy rails the replies indicate about an even division of opinion.

Chapter IV considers the effect of wheel load, and spacing of the locomotive on the track and the prevailing practice in America in this respect. With the single exception of the Prairie (2-6-2) type, all engines reported for passenger service have the four-wheel truck introduced by Jervis in 1832, and the statement is true generally for the passenger service of the railroads for all countries. For high speeds, the four-wheel leading truck has a large factor of safety. The maximum axle and total loads of the locomotives reported are the greatest yet collected for the International Railway Congress. Compared with those used before the transition to the stiffer rails, they are twice as heavy, with a corresponding increase in effective tractive power. The latter must be considered in rails for lines with fast trains, for it increases the stresses in the rails from 20 to 40 per cent. according to the type of the locomotive.

The American or eight-wheel type of engine is reported by all railroads, but is being replaced for fast and heavy passenger service by 10-wheel, Atlantic, Pacific and Prairie types; having heating surfaces of 3,000 to 3,500 sq. ft. For the fast trains of 200 to 250 tons weight, the Atlantic type is in general use. For the heavy passenger and mail trains of 500 to 600 tons, running on fast schedules, the 10-wheel and Pacific types are generally used. For freight service, Moguls, 10-wheel, Consolidation and the 12-wheel types, are principally used. Train loads of 3,000 to 4,000 tons are common practice on lines without mountain gradients.

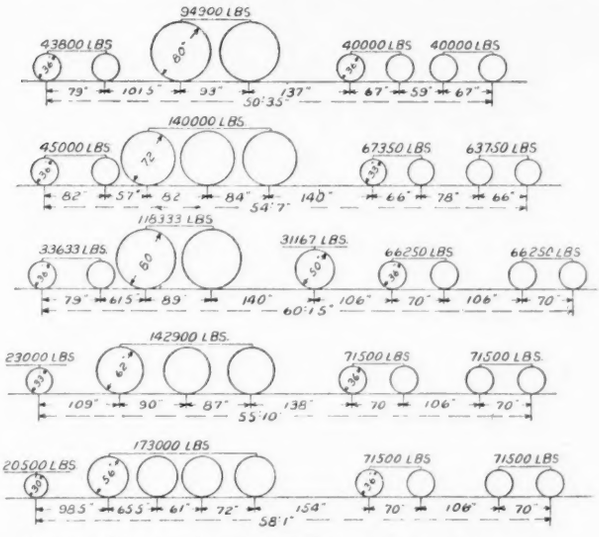
In the designs of the large types of locomotives, they are following technical lines of construction, as powerful generators and motors, rather than the relation between them and the permanent way as developed by long experience. The tender as a part of the locomotive to be in the same "General Depression," does not receive its full consideration as a factor, through the drawbar-pull, in distributing the total load to the rails and foundation. The wheel spacing should be short between the rear driver and the front tender wheels, to continue the depression of the rails and subgrade from the engine to the tender, making it continuous for the locomotive. A pair of trailing wheels has been added, in recent designs of large freight locomotives, which will be of advantage.

The drawbar-pull, and the tender, on stiff rails, can become important factors in distributing the effect of the expended tractive power to a longer portion of the track than that occupied by the driving wheel base. On 100-lb. rails, with the Atlantic type locomotives it may be extended to the entire wheel base of the locomotive. The expended tractive power for the large freight locomotives, through the several pairs of driving wheels, becomes distributed, and does not increase proportionately the stresses under all the driving wheels, as is the case with the eight-wheel or the Atlantic type of engines.

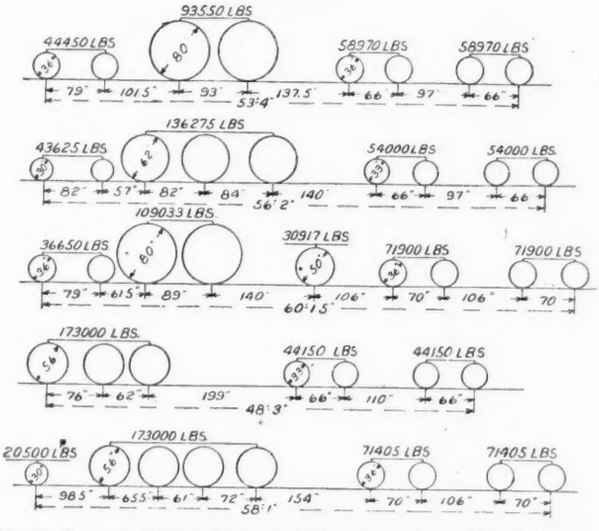
The locomotive should be considered as a generator, motor, and machine, in drawing the train and distributing its load to the rails and foundation. The size of the driving wheels, and the height of the drawbar between the engine and tender, are factors in increasing the loads of the wheels under the tender. The center of the drawbar, for the cars, is about 35 in. from the top of the rail, but between the engine and tender it is higher usually in the engines with driving wheels 6 ft. or more in diameter. More attention should be given to reduce the irregular action of the driving wheels per revolution upon the rails for the fast passenger trains. Considerable relief to the track can be expected from the employment of four-cylinder engines, acting upon each quarter of the crank, for high speed passenger service.

In a series of tests to ascertain the distribution of the stresses in rails under moving locomotives, it was found with wheels in good condition and for speeds up to 50 miles per hour, that the sum of the different wheel effects includes the entire weight and effect of the locomotive, as though distributed from its center of gravity through the wheel contacts to the rails, crossties, ballast and the subgrade. It is in action and effect a distributed and not a concentrated load.

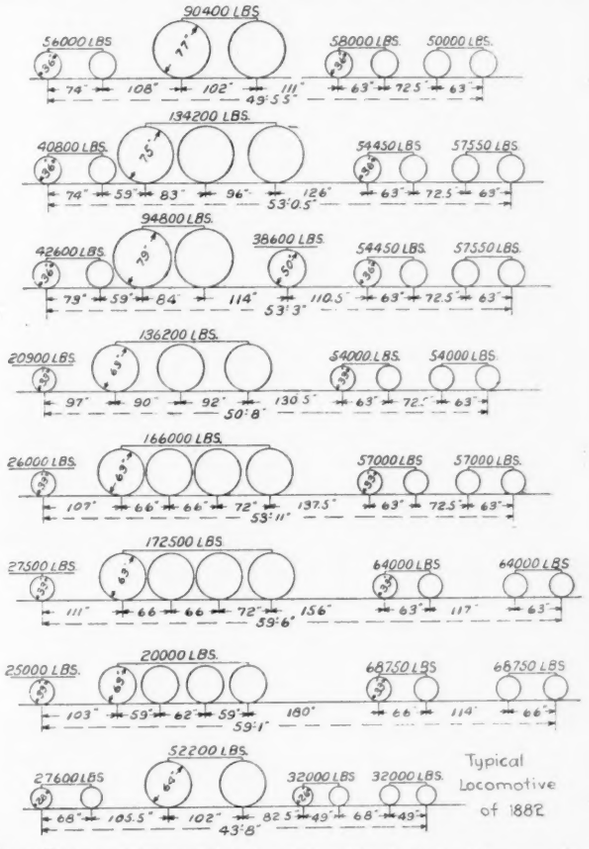
With the Consolidation and 12-wheel types of engines for freight service, the distribution of the total load upon the rails as gir-



Wheel Base and Wheel Loads of Pennsylvania Railroad Locomotives.



Wheel Base and Wheel Loads of Penn. L. W. Locomotives.



Wheel Base and Wheel Loads of New York Central Locomotives.

ders can be made through the different wheel contacts, so that it is not excessive upon the rail or the foundation.

The bending moments in the rails under the wheel contacts, are not as a rule as large for the heavy freight locomotives, as those under the faster moving passenger engines. The space between the rear driver and front tender wheel as stated already, should be such that the "General Depression" formed by the engine and the tender will be continuous for the locomotive. If this space is too long, then the engine and tender each produce a "General Depression," increasing not only the train resistance, but the stresses, and cause greater deformation of the foundation under the locomotive. The study of rail sections is incomplete without the knowledge of the locomotives which run over them, as the highest efficiency of either is due to their conjoint action. Stremmatograph tests serve to explain and confirm the American theory and practice that the wheels and wheel spacing of the locomotives are important factors in distributing their total loads to the rails, crossties and the foundation.

The drawbar-pull is an important aid in the distribution of the load of the locomotive, on 100-lb. rails, to the entire length of the wheel base. The depression of the rail from the trackman's surface to the lower running surface in the "General Depression," changes the character of the rail section from a simple to a constrained beam. The rail section is not only stiffened to resist deflections, but it is actually strengthened to carry the driving wheel loads, and thus becomes a more important factor in increasing the combined stability between the locomotive and the permanent way than is usually considered.

The reports from railroads show that locomotives of the Pennsylvania Railroad have the longest tenders of any. This is important, in distributing not only the total load of the locomotive to a longer portion of the track, but contributing to the ease of motion of the car attached. One diagram of wheel loads and spacing of New York Central & Hudson River Railroad locomotives, of 1882 prior to the general introduction of the stiffer rails, is added for comparison. The diagrams for the different railroads show unimportant variations as to wheel spacing, etc., which could be reduced to standard dimensions, and constructions for classes for each type, in which the most favorable wheel base for the rails and subgrade should enter for consideration with other factors in the design.

(To be continued.)

Henry V. Poor.

Henry Varnum Poor, who died on Wednesday, Jan. 4, 1905, was born in Andover, Oxford County, Maine, Dec. 8, 1812, and was graduated in the class of 1835 from Bowdoin College, subsequently being admitted to the Bar of his native state. His law practice occupied his attention until 1848, when he went to New York City, where, in 1849, he became the editor of *The American Railroad Journal*, the first and, at that time, the only publication devoted to railroad affairs issued in the United States. While still editor of the *Railroad Journal* he planned and with the assistance of Dr. Richard Swainson Fisher undertook the publication of what was projected to be the most elaborate work of its kind ever attempted in this country, in respect to the progress of its internal improvements, the "History of the Railroads and Canals of the United States of America, Exhibiting their Progress, Cost, Revenues, Expenditures and Present Condition." This work, stupendous at the period, was to appear in three volumes, but Vol. 1, embracing in 612 pp. the railroads of the New England and the Middle States, which was published in 1860, marked the full extent of the completion of the enterprise, the outbreak of the Civil War interfering with the fulfilment of the project.

Shortly after this Mr. Poor retired from the *Railroad Journal*, but in 1867 re-entered the field of railway economics, and began preparations for the publication of the first number of the Manual of the Railroads of the United States, having associated with him in this new enterprise his son, Henry William, under the firm name of H. V. & H. W. Poor, with offices at 57 and later at 68 Broadway, New York City. The Manual was started as an adjunct to the importation of rails and other business of a like character which the firm at that time carried on. The collecting of railroad statistics at that time in the thorough and careful manner in which it was done was of enormous importance. Indeed, it may be said that in those days, and up to 1888, no one could become a railroad authority without Poor's Manual, although the Interstate Reports in recent times have taken away some of its exclusive value for totals and averages.

Mr. Poor's position in railroad affairs was unique. His youth and early manhood having been contemporary with the early development of canal building and railroad transportation, he speedily became interested in all projects that promised to assist in the more rapid development of the eastern country, and in natural order to all propositions for the opening up of the western country. In this way he became associated, in 1864, with Gen. John A. Dix, Thomas C. Durant, Geo. Opdyke, Geo. T. M. Davis, A. G. Jurome, J. F. D. Lanier, William B. Ogden, H. S. McComb and others in the organization of the Union Pacific Railroad Company, of which Mr. Poor was the first secretary.

Henry V. Poor.

Mr. Poor was a forceful, and, when occasion required it, a trenchant writer on all subjects that engaged his attention, but particularly so when those subjects concerned the financial and economic problems of the day. His most important work, "Money: Its Laws and History," attracted world-wide attention, because of the independence of thought it displayed; and the keenness of his shafts aroused the ire of many of those who worshipped at the altars of earlier publicists. Besides this, Mr. Poor was the author of many books covering a wide range of economic subjects, such as the Silver Question, Resumption, Protection, The Tariff, Railroad Law and Legislation, etc. He was a consistent and stalwart opponent of demagogism as directed against railroad capital and enterprise, but never an apologist for railroad rapacity or dishonest methods of railroad financiering. His notes of warning, though not always heeded at the time delivered, are fruitful evidences of his farsightedness.

At the time of his death, Mr. Poor was not only the oldest living graduate of Bowdoin College, but, also, the only surviving charter member of the American Geographical Society, which recently celebrated the fiftieth anniversary of its incorporation. For a number of years past Mr. Poor had not been actively engaged in business, spending his winters in Brookline, Mass., and his summers in Andover, Me., his birthplace, and devoting his leisure to his favorite occupation, his books and writing. Shortly before his death he had under advisement the preparation of a paper on the development of railroad, canal and river transportation, to be read at the forthcoming meeting of the International Railway Congress, in Washington, a subject that he was pre-eminently fitted to discuss.

Mr. Poor is survived by his widow and son, Henry W., of the firm of H. W. Poor & Co., bankers, New York and Boston, and by three daughters.

Uniformity in Technical Analysis.

The December journal of the American Chemical Society contains a valuable report from the committee on uniformity in technical analysis. The committee consists of Messrs. W. F. Hillebrand, Chas. B. Dudley, H. N. Stokes and Clifford Richardson. A review of previous work, together with examples of variations in results from different chemists is given. The following table shows the extreme results obtained by 42 chemists in analyses of three different samples of zinc ores:

	Sample 1.		Sample 2.		Sample 3.	
	Zinc.	Iron.	Zinc.	Iron.	Zinc.	Iron.
High	59.73	3.26	39.22	21.92	38.86	15.00
Low	56.03	2.10	12.20	18.04	28.90	8.40

Of the 42 chemists, 23 are, or were, in zinc works where zinc is frequently determined; 11 were commercial chemists, most of whom make a specialty of zinc, and five were professors or instructors in colleges.

The committee has adopted the following policy for the guidance of its work:

(1.) To use every endeavor to impress upon chemists the necessity for such changes, either in methods of analysis or of manipulation, together with a control of the purity of reagents in use, as will make it possible to arrive at greater uniformity in the results of analyses made by different analysts.

(2.) To determine whether the lack of uniformity is to be attributed to lack of proper instruction in our schools or to mere carelessness in manipulation, by inviting the co-operation of the instructors in analytical chemistry in the work, distributing among them standard material for analysis the results of the analysis of which shall demonstrate the accuracy of the method taught by them.

(3.) To test, in conjunction with the National Bureau of Standards, various methods, and determine their accuracy and suitability for general use.

It may be said in this connection that the hearty co-operation of the Bureau of Standards has been promised, contingent only on the appropriation by Congress of the funds needed to secure the help of competent chemists. Application for such an appropriation will be made at the coming session of Congress, and it is the desire of the committee that friends of this movement use what influence they may possess to forward

it. This may be done, in part, by presenting in writing to the director of the bureau arguments in favor of co-operation, especially when strengthened by a clear statement of specific problems whose settlement may have commercial importance.

(4.) To prepare samples of materials of different character whose exact composition shall have been determined by the most careful analyses of experts.

(5.) To place such samples in the care of the National Bureau of Standards for preservation and distribution to persons desiring to test their methods of analysis or of manipulation, or to check the work of students or technical chemists employed in works.

(6.) To invite the co-operation of persons interested in the analysis of any particular class of material, by the organization of sub-committees for the preparation and distribution of samples, the chairman of which shall be, for the time being, a member of the general committee and entitled to vote on the subject which his sub-committee has under consideration.

It will not be the policy of this committee to commit the society as a body to the endorsement of any methods as standard, but merely to recommend such as may be found satisfactory. Nor will the committee intrude on fields of work that may be already well covered by existing organizations, such as the Society of Official Agricultural Chemists.

Methods of Location on the Choctaw, Oklahoma & Gulf Railroad.

BY F. LAVIS, ASSOC. M. AM. SOC. C. E.

(*Concluded from page 15.*)

Topography.—This was taken for 300 ft. on each side of the line, in cross-section books, ruled, on a scale of 8 ft. to 1 in., in 100-ft. squares, subdivided into 10-ft. squares.

In the field a hand-level and a light wooden rod, 2 in. by ¾ in. by 12 ft., marked every ½ ft., were used, and distances out were paced, or measured with a cloth tape, according to the nature of the ground, and 5-ft. contours were located and sketched in, care being taken at angle points to get sufficient information to connect the contours properly on the map.

Each day the books used on the previous day were left in camp, and the work platted by the draftsman, and other books were taken out. Each book was indexed each night, and each day's work dated at beginning and end.

On the final location, a sounding party was organized, with topographer No. 1 in charge, and two or three laborers; soundings were taken in all the cuts and at bridge openings, ship augers and steel drills being used most generally. The former were welded to a 12-ft. steel rod with an adjustable handle. These soundings, taken with augers, determined very closely the character of the material in the cuts. In country where boulders might be likely to be encountered to any great extent, either in a clay or gravel formation, this method would not answer; but through the country traversed, as proved on construction, the estimates made from the results of these borings and a close study of the country were quite near the final estimate.

In one or two instances, of important structures and very deep cuts, a regular well-drilling outfit was secured, and the work looked after by a man engaged for the purpose under the direction of the locating engineer.

The second topographer, supplied with a transit and assisted by the two tapemen, determined the drainage areas, located the property lines and section corners, got names of property owners, etc. This method was found much more economical than to have the whole transit party held up while the transitman and chainmen were getting this information.

With the information thus obtained by the two topographers, the profiles and map of the final location, which were finished within a few days of the completion of the survey, contained all the information necessary to proceed with the construction.

It should be noted here that there were exceptional circumstances in connection with this survey which made it desirable to employ two topographers. Ordinarily, one is sufficient, and a good man will easily take 80 per cent. of the topography. Generally, about moving day, the topographer is a day or two behind, in which case the whole party is broken up into topographpical parties, and the work cleaned up to the end of the line in a part of a day. Also, when only one topographer is available, when the final location is run in, the Assistant Locating Engineer is occupied about two thirds of the time in getting land lines, drainage areas, etc., and assisting with the office work, while the locating engineer looks after the actual running in of the line. This is ordinarily the most economical arrangement, but, in the survey referred to, it was necessary to rush the work, regardless of the slight extra expense of using men occasionally at a disadvantage.

In carrying out the third requirement of keeping headquarters in touch with the work, a weekly report was made by the locating engineer, and the following maps, etc., were kept in shape and up to date:

On preliminary lines: General map, scale 5,000 ft. to 1 in., at the bottom of which was a condensed profile of the projected location, scales 1,000 and 100; detail map, scale, 400 ft. to 1 in.; profiles of preliminary lines and profile of projected location, plate A paper, scales 400 and 20; profile of projected location on tracing profile paper.

On final location: Line inked in on 400-ft. map, and drainage area shown; right-of-way map, scale 2,000 ft. to 1 in. (required only in Indian Territory); maps of station grounds, scale 100 ft. to 1 in.; final profile on plate A paper; final profile on tracing profile paper, in 10-mile sections.

Ravine Sections of all Bridge Sites.—The first duty of the field draftsman was the preparation of the general map on the 5,000-ft. to 1-in. scale, from the best available sources, covering the whole of the country in which the proposed line might lie. In most of the country in the west, where topographical maps have not yet been prepared, the Government maps of the Public Land Surveys, showing the section, township and county lines, town sites, and the location of the main drainage, will form the basis of this map.

This 5,000-ft. map and profile are absolutely essential to a broad, comprehensive study of the line as a whole; it can be readily seen from this whether or not a good general direction is being maintained, and the general relation of the line to the surrounding country is shown. Such a map, with the omission of the preliminary lines, is of considerable aid to contractors in computing the haul of construction material and for other uses; it is also generally sufficient to accompany such reports as are made to the higher officials, in fact, it gives them a more comprehensive idea of the line than a more detailed map. Fig. 5 shows a portion of a 5,000-ft. map, but shows the located line only; the writer regrets that he has not available a map as described, showing also the preliminary lines and condensed profile.

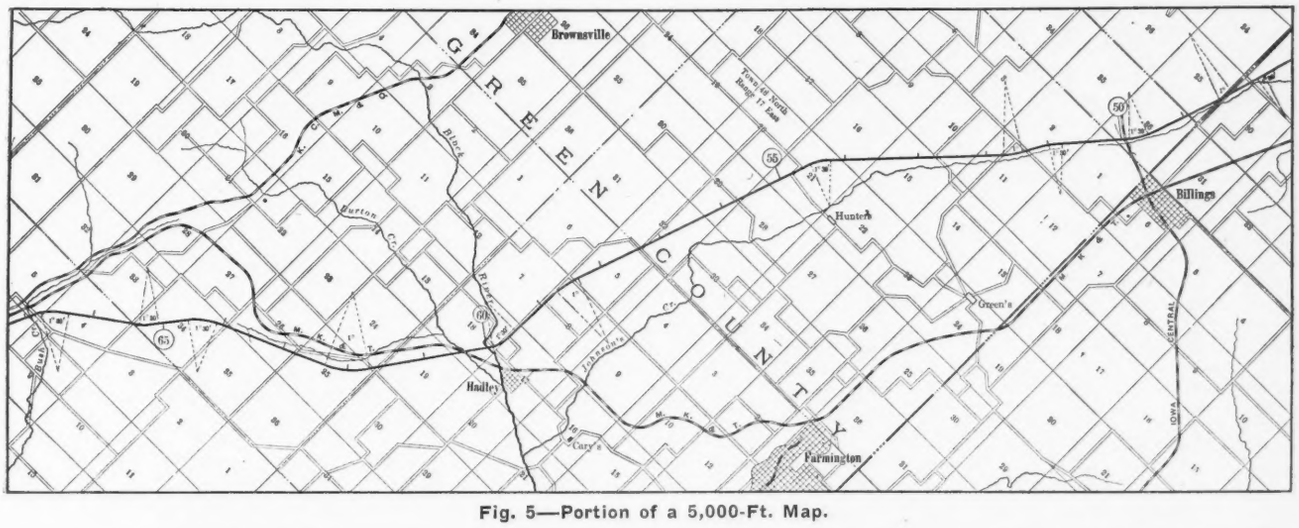


Fig. 5—Portion of a 5,000-Ft. Map.

A tracing was made of this map and, as soon as completed, sent to headquarters; from day to day, the preliminary lines run were platted on it, and, also, the projected location and profile, as they were made.

At the end of each week a tracing of the portion of the map showing the additions

*Extract from a paper presented to the American Society of Civil Engineers and printed in the *Proceedings*, page 864, December, 1904.

made to it during the previous week was sent to headquarters, where the information was transferred to the original tracing.

The weekly report which accompanied this map explained in quite full detail such points in connection with it and the work as seemed to require explanation. It explained, in particular, the natural features of the country, the availability or otherwise of timber (especially for ties), stone, sand, etc., the condition of roads, water supply, and, in general, the work of the party during the preceding week.

All the preliminary lines run during the day were platted on the 400-ft. to 1-in. map in the evening, from the calculated courses and distances; no platting from deflection angles was allowed. The work of the draftsman was checked by the assistant locating engineer.

The first thing the following day, the line was inked in, in red, station numbers were marked at all angle points, the topography taken the previous day was platted and inked in immediately in black. Black was found preferable for the contours, as it stood the erasing of the projected lines better than colors. Valleys were indicated by a light blue line drawn throught the lowest points, thus making the topography stand out and easier to read. It was found necessary at times to have one topographer stay in half a day and assist the draftsman by platting the topography, in order to keep all the parts of the work co-ordinated.

With the large party used, more than four miles per day of preliminary were averaged, and it was absolutely necessary to keep the topography close up, in order that the projected location should not get behind. As a rule, as the map was being used in the evening and the early part of the day, the locating engineer endeavored to get back to camp about 4 p.m. and get the projected location up to date before supper. Separate sheets, as advocated by Mr. Wellington in his "Economic Theory," may have some advantage in this respect, but the writer prefers the map on a roll of 36-in. paper. There are few places in difficult country where it is not necessary to run more than one line, and it has always seemed to the writer to detract from a general, broad, comprehensive study of the lines, as a whole, to have them scattered around on separate small sheets of paper.

Necessarily, also, by the separate sheet method, the lines and topography must start right from the edge on one side of the sheet, where it is very likely to be torn; on the 36-in. rolls used on this survey, no topography was allowed within 6 in. of the edge of the paper, except possibly at a point where it just came near the edge and immediately receded from it.

It was absolutely required that the projected location should fall within the limits of the topography; that is, within 300 ft. of the preliminary line, and if, for any considerable distance, it was more than 200 ft. from the preliminary line, it was often deemed advisable to cover this with another line. In making the projected location, a sheet of tracing cloth, on which was drawn in ink to the scale of the map the curves proposed to be used, with tangents at the ends, was found very useful in fitting the alinement; 100-ft. stations were marked on these curves on the tracing cloth, so that, when laid above the topography sheet, pieces of profile could be readily read off. No P. C. or P. T. was allowed to come within 400 ft. of the end of a bridge; all curves were of even degree of curvature, being either 1, 2, 3 or 4 deg., and all grades were in even tenths of 1 per cent.

The writer objected to the limitations of the degrees of curve at first, believing that a nicer adjustment could be made by using any degree, with indices of odd minutes when necessary, that seemed at first to fit the ground better, but by being compelled to use the even degrees, found afterward that this could be done almost invariably just as well, but required perhaps more study of th esituation. Of course, no rules of this kind can be absolutely iron-clad, and the principal assistant engineer at times modified them himself, but it was considered advisable to make them binding as far as the locating engineers were concerned.

The projected location being made and penciled in on the 400-ft. map, the profile was taken off and the grade line fixed, grades being kept in even tenths of 1 per cent., except where compensated for curvature, and even then, if possible. Of course, in long stretches of ruling grade where often every inch counts, hundredths of 1 per cent. rates occurred where compensation was made. Breaks for compensation were made at the even stations nearest the ends of the curves.

All bridges and culverts were located on this profile, the probable quantity of classified excavation in each cut was indicated, and an estimate made of each mile. The classification of the material in the cuts, as shown on this projected profile, was made by the Locating Engineer from his observations of the surface indications; of course, this was only approximate, but was quite close.

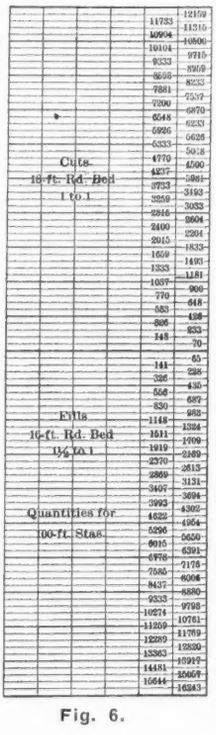


Fig. 6.

Specifications and standard plans of all structures, with tables of constant quantities, were furnished by the railroad, and the excavation and embankment quantities were figured from tables of level cuttings for the standard roadbed sections used. A useful device for scaling the quantities from the profile was made by taking a piece of the same profile paper used for the profile and marking, along the edge at each foot, the quantities corresponding to the height, starting at 0 (see Fig. 6).

As each 10 miles of this profile of the projected location was completed, a tracing on tracing profile paper was made, showing the estimated quantities of each mile and, also, on a regular estimate blank, a summary of quantities, and a summary showing: Total length; total degrees of curve; total length of tangent; total percentage of line on curve; maximum curve; maximum grade; total rise (in the direction of the line); total fall (in the direction of the line); total length of bridging; total cost; average cost per mile; average number of cubic yards per mile.

These tracings of 10 miles each, with the estimates and summary, were forwarded to headquarters as fast as completed, and, on the completion of the line, an estimate and statement similar to the above, covering the whole line, was sent in. The original profile was made in 25 to 30 mile sections.

From time to time the Principal Assistant Engineer visited each locating party in the field, and thus kept in touch with the work an dresults of each. At the same time, the 5,000-ft. map and profile, etc., kept the record at headquarters complete. All projections adopted for location were examined and approved by the principal assistant engineer, and, after approval, no deviation was permitted without authorization. By this means a detailed study of the line was possible; much more so than when viewed only on the ground by those superior to the locating engineer.

On the particular line in question, it was decided, by the time the different preliminary lines were connected, that a 0.5 per cent. grade was possible for the whole length of the line, and instructions were given to make this the ruling grade on the final location.

Instructions were given the locating engineers to spend all the time necessary on investigations, to be sure they had the best line through the country traversed before putting in the location, on the ground. The writer recalls one stretch of line, about 16 miles in length, where he spent nearly three weeks, running over 80 miles of preliminaries, besides the original preliminary and projected location, before the final line was decided on. A second projected location saved a mile of distance over the first, besides eliminating much curvature and rise and fall, and, but for the very positive instructions received to exhaust every possibility, and the receipt, about this time, of a letter from the principal assistant engineer, who knew the difficult nature of the country, reiterating his caution, this line would have been run in. Other lines were run, the final location effecting a saving of more than $30,000 in estimated cost of construction and eliminating many degrees of curvature and more rise and fall.

It seems hardly possible, in view of this, which is only one case out of thousands, that any one contemplating the construction of a railroad should hesitate to spend sufficient money on surveys, but all engineers of any extended experience know how difficult it often is to get either sufficient time or money to do this work thoroughly; and, as a result, how very much more the cost of the needless construction is likely to be than that of the surveys. Still, the writer believes it is often the fault of engineers in charge of work that this is so. Men nowadays investing their money in any project of merit are as a rule level-headed business men who would be willing to furnish all the money necessary for proper surveys, if the matter were presented to them in the proper light.

As the final located line was run in, it was inked in on the 400-ft. map, radii of curves were drawn, stations of P. C. and P. T. marked, and calculated courses of tangents from observations of Polaris, length of tangents, the degree of curve, central angle, and the length of semi-tangents noted at each curve; drainage areas, as definitely determined by the topographer, were dotted in, and areas noted; as were also property lines and owners' names, thus making the map a complete record (see Fig. 7).

In Indian Territory a right-of-way map on a scale of 2,000 ft. to 1 in. was made showing the alinement, station of P. C. and P. T. of curves, central angle, degree and length; also length and calculated course of tangents, all property lines and plusses to same, and property owners' names, where land had been allotted; ties to all section or quarter-section corners nearest the line, and notes in pencil where extra width for large cuts or fills might be necessary, the final width desired being added at headquarters. This map was required in Indian Territory

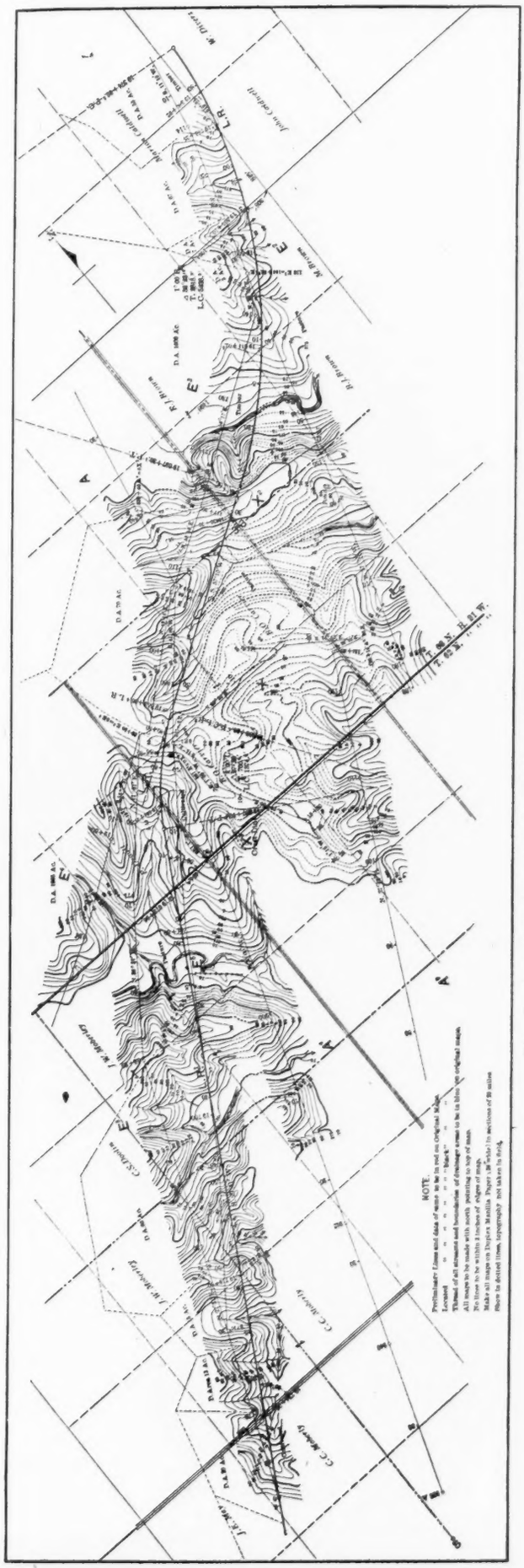


Fig. 7—Complete Map Showing Final Location, Topography, Etc.

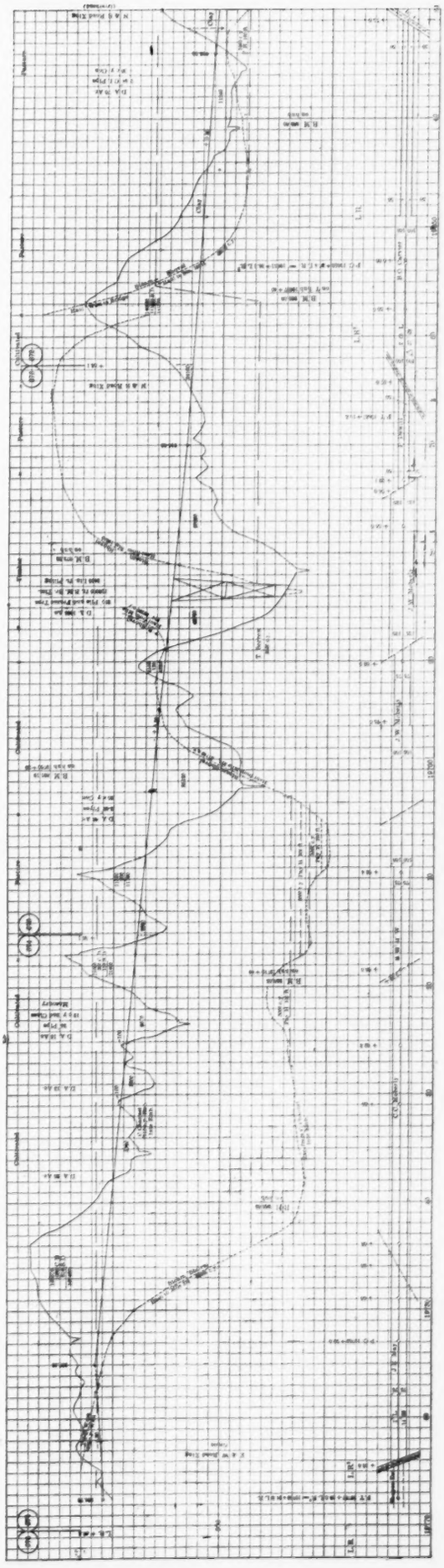


Fig. 8—Profile of Final Location.

only, to meet the Government requirements, the right of way being obtained by filing such a map with the Secretary of the Interior.

As the final profile and the ravine sections were platted, they were taken into the field by the locating engineer, and all bridge openings and culverts carefully fixed there. The profile as platted was inked in, but the grade line was left in pencil. As soon as the openings were fixed, and the soundings noted at the bridge sites and cuts, the estimate of quantities and the cost of each mile were made up by the draftsman and checked by other members of the party; this was then all carefully inked in, and a tracing made. Profiles of final locations were made in 25-mile sections. A portion of such a profile is shown in Fig. 8. This profile and the 5,000-ft. map contain all the information necessary to enable a contractor to bid intelligently on the work, and as all this work was kept up together, it was immediately available on the completion of the surveys.

The tracing of the profile of the final location was sent in to headquarters as soon as a 25-mile section was completed, together with the right-of-way map and ravine sections covering the same ground.

On receiving notice from headquarters that the grade line, as shown on the tracing profile, had been approved, the grade line on the original was inked in, any changes that were ordered being made, and then this was ready for the Division Engineer having charge of the construction of that section. Reference to the "Instructions to Resident Engineers" on the Choctaw, Oklahoma & Gulf Railroad, by Messrs. Molitor and Beard, will show how the work of construction was co-ordinated with that on the location.

All maps and profiles were carefully lettered in ink on the outside at each end, the lettering running parallel with the axes of the rolls, showing just what they were. On the 400-ft. map, the title might be something as follows:

New York—Boston Line.
Providence—New London Section,
John Smith, Locating Engineer.
Final Location Sta. 852 to 1748. Mile 56 to Mile 73.
Preliminary Sta. A... 934 to 1823.
" " M... 48 " 223.
" " N... 15 " 329.
" " O... 0 " 56.
" " B.B. 17 " 638.

The maps accompanying this paper are reproductions of maps actually made in the field, and show more clearly than any written description the kind of work accomplished.

The following is a statement showing in detail the cost of surveys conducted practically in accordance with the practice outlined in this paper. The length of the final located line in this instance was 179 miles, and the work was divided between four parties. The country was similar to that described by the writer, that is, long rolling country, rather badly broken up, the line running across the drainage, necessitating the exploration of a wide range of country on either side of the proposed route. The average amount of grading per mile was about 100,000 cu. yds.; maximum grade, 0.5 per cent.; maximum curve, 2 deg.; there was 19 per cent. of the line on curve. The writer is especially indebted to Mr. Beard for this information and notes on the same, as well as for much valuable assistance in the preparation of this paper.

Field expense:	
Preliminary, for 563 miles	$14,628.97
Preliminary, per mile	25.98
Location, for 179 miles	12,597.92
Location per mile	70.38
Locating party No. 1: Expense on preliminary, incident to above location, and including preliminary and location of 9 miles.	2,478.02
Office expense charged to above	6,446.08
Total cost of preliminary and location, 188 miles	$36,150.99
Total, cost per mile	192.30

Preliminary Lines.

	Party No. 1. July 5 to Oct. 1. 87 days.	Party No. 2. July 22 to Oct. 20. 90 days.	Party No. 3. Aug. 1 to Nov. 19. 111 days.	Party No. 4. Sept. 21 to Oct. 21. 30 days.
Miles run and topography taken	145.8	166.3	164.1	23.2
Miles run, no topography taken	39.3	.....	16.0	3.6
Total miles preliminary run	185.1	166.3	180.1	31.8
Total number payroll days	1,380	1,323	2,033	635
Average daily number of men	15.9	14.7	18.3	21.2
Average miles per day per party	2.12	1.85	1.62	1.06
Total cost of subsistence	$513.18	$646.42	$763.53	$371.47
Average daily cost, subsistence per man	$0.37	$0.49	$0.38	$0.58
Relative cost percentage to lowest man subsistence	100	133	103	157
Total payroll cost (except teams)	$2,502.55	$2,683.22	$3,381.56	$1,055.55
Average daily pay per man	$1.81	$2.03	$1.66	$1.66
Total cost for teams	$522.00	$560.23	$768.55	$386.15
Daily cost for teams	$6.00	$6.22	$6.92	$12.87
Contingencies	$88.48	$112.95	$91.84	$125.73
Total cost of party	$3,629.96	$4,002.82	$5,057.96	$1,938.23
Daily cost of party	$41.72	$44.48	$45.57	$64.61
Daily cost per man	$2.63	$3.03	$2.49	$3.05
Cost per mile	$19.61	$24.07	$28.08	$60.95
Relative percentage to lowest man per mile	100	123	143	311

Located Lines.

	Party No. 1. 65 days.	Party No. 2. 37 days.	Party No. 3. 8 days.	Parties Nos. 2 & 3.* 48 days.	Party No. 4. 66 days.
Miles located	56.0	37.8	7.6	42.6	39.2
Total number payroll days	1,400	709	151	1,498	1,283
Average daily number of men	21.5	19.0	19.0	31.2	19.4
Average miles per day per party	0.86	1.02	0.95	0.89	0.59
Total cost subsistence	$515.55	$273.07	$59.50	$599.20	$574.65
Average daily cost subsistence	$0.37	$0.39	$0.39	$0.40	$0.45
Total payroll (except teams)	$2,410.10	$1,143,11	$242.70	$2,562,74	$2,049.25
Average daily pay per man	$1.72	$1.61	$1.61	$1.71	$1.60
Total cost for teams	$434.74	$212.71	$43.10	$496.00	$445.85
Daily cost for teams	$6.69	$5.75	$5.39	$10.33	$6.76
Contingencies	$143.36	$46.76	$15.70	$196.00	$133.84
Total cost of party	$3,563.75	$1,675.65	$361.00	$3,893.94	$3,203.59
Daily cost of party	$53.90	$45.22	$45.12	$80.29	$48.54
Daily cost per man	$2.50	$2.36	$2.39	$2.57	$2.50
Cost per mile	$62.57	$44.33	$47.50	$90.47	$81.72
Relative percentage to lowest man per mile	141	100	107	204	184

*Combined.

There are various things to be taken into consideration in judging the fluctuations in the cost of these surveys. The preliminary location by party No. 1 was over a severe country and embraced the heaviest work on the whole line; at the same time, much difficulty was experienced in getting a grade between certain points on the line located by party No. 3. Party No. 2 had the lightest country.

There is charged to the expense of party No. 4, the cost of moving a long distance from other work to this line, which amount, together with the short time they were engaged on preliminary, abnormally increased the cost of their work; at the same time, it is evident that this was decidedly the most expensive party on the work, their work per unit of cost, costing more.

For instance, their subsistence was 57 per cent. more than that of party No. 1, and the team hire more than double that of the other parties; while the actual number of men in the field was relatively the same. It is probable that the cost of the work done by this party was really about 60 per cent. more than the others instead of 200 per cent., as shown by the cost per mile.

On location, party No. 1 carried a very heavy and expensive sounding party, consisting of a man in charge, four or five laborers and a team; the nature of this work was such that it was much more expensive than that conducted by any of the other parties.

After completing the location, party No. 1 was engaged in running other preliminaries and locating a short branch, the cost of this work not being distributed, but included in the total cost of the survey, the amount being $2,478.02.

On location, parties Nos. 2 and 3 were combined after each had run in a short distance separately; this was necessitated by the approaching cold weather and the desire to complete the location at the earliest possible moment; the result shows it to have been an uneconomical proposition as far as cost per mile is concerned; but both of these parties had much additional preliminary work to perform as they proceeded with the location.

What has been noted of party No. 4 on preliminary is true on location, though its cost is somewhat burdened by the charges incident to moving the party elsewhere, and the fact of its happening about Christmas, when many men were given vacations with pay. This Christmas expense was encountered to a somewhat less extent by every one of the parties, and tended to increase the total cost, but taken as to parties Nos. 1, 2 and 3, the statement is a fair average of what a thorough survey under like conditions will cost.

Besides the organization, which was practically the same as that engaged on these surveys, with the exception that there was only one topographer, there was the expense of an expert, at $150 per month and his expenses, engaged in an examination of the country adjacent to the line, for the purpose of determining the quantity of sand and stone available for construction purposes. The amount of this expense is $545.84.

In all this work it was considered absolutely necessary that all parts of it should be kept up together, and, with the large party available, it was found feasible to assign the men so that any part of the work which lagged behind could be brought up to date; the weak point is, of course, with the leveler on preliminary, if he gets behind there is little to do but to wait until he catches up. It is necessary, therefore, that an especially good man should be selected for this position. Physical ability to hustle is absolutely necessary, and the rodman must expect to trot between stations and the instrumentman between set-ups, if they cannot keep up by walking.

The leveler in a party should be, not only accurate, but quick. As an instance of what can be accomplished: On one of the lines referred to, starting from the west, more than 100 miles of preliminary were run to the eastern end of the line in 20 working days (not including Sundays and moving camp). On one day, the leveler covered eight miles. On returning and making the final location, when every care was taken to have the levels as accurate as possible, equalization of sights being insisted on, and there being ample time for the leveler to do the work properly, no variation from any bench-mark was found greater than $^{5}/_{10}$ ft., the final check on the bench at the western end being about $^{3}/_{10}$ ft.

In making the preliminary location, or

rather, the writer would prefer to say, in running the preliminary lines, he considers that the result to be obtained should be regarded more in the nature of making a topographical map of a strip of country through which the final location will pass, and through which runs a sufficiently accurate base line or lines, than in running a line which will be very close to the final location. There is only one place, in his opinion, to adjust the final location, and that is on a good topographical map.

This, of course, will not be misunderstood as relieving the locating engineer of the necessity of running these preliminary lines with judgment and a good idea of their relation to the located line. All the good judgment and "eye for country," relied on so much by some of the older locating engineers, are still as necessary as ever, but they must be supplemented by scientific methods and hard work.

The statement in regard to the final adjustment will possibly evoke some discussion from the many men who have saved thousands of dollars by slightly changing a curve in the field or otherwise after the final location is made, and the writer will admit, of course, that there is hardly a line located to-day, or likely to be, where every foot of it is exactly where it ought to be, but, in anything but the most minor changes, he believes that the fault will invariably be found in the fact that the original topographical map was not correct, or the projection not well made.

Provided the topography is generally correct, which it should be to be of any use at all, it is possible to project a line on it, which will be the best line the country affords, and, if the work is properly done, this line can be laid out on the ground. In adjusting the line to the topography, the line can be changed and a profile obtained 15 times on the map while it is being changed once on the ground, and all the problems affected by the change studied.

The writer is well aware, of course, that the practice as outlined in this paper will necessarily be subject to many modifications to meet different conditions.

In conducting surveys in tropical countries or in other places where it is difficult to obtain experienced engineers, and then only at largely increased salaries (in tropical countries about two or three times as much as is noted in this paper), other methods become necessary, but the writer believes that the same ends should be striven for. In these cases, there is a great temptation to the engineer in charge of such work to shrink from the responsibility of insisting that he be given *carte blanche* by his employers in the matter of engaging such assistance as he may need and in the payment to them of adequate salaries.

There is much mountain country where transportation is extremely difficult, where everything possible must be done to lighten the equipment, and where a great deal of reconnaissance can be done in more or less detail with a light party, either by a separate party ahead of a larger one, or before a larger party is organized and put in the field.

Such a party can do much good work with a transit used as a level, or by using the stadia, in eliminating certain entirely impractical lines. In any event, under such conditions, both parties should be controlled by the same man, as what might have been regarded as impractical under one set of conditions may become entirely so under others; all this, however, is matter which will suggest itself to the experienced locator.

There are probably many old locating engineers, many who have done excellent work with much less equipment and fewer men, who will hold up their hands in horror against such an organization and equipment as is outlined here, but railroads themselves, as they exist to-day, are all the evidence necessary to prove that other methods than those of the past are necessary to meet changed conditions. Scientific methods must be applied to the conduct of location, as well as to the design of bridges, terminals, locomotives, etc.; in fact, on a proper location or otherwise the future of the railroad is almost entirely dependent.

In submitting this paper to the consideration of the society, the writer does not wish to be understood as advocating any hard and fast rules for railroad location. No two lines are alike, topography is never the same, and nothing will take the place of experience, good judgment and much hard work. He knows there are many good locating engineers who entertain different ideas, and he hopes they will submit them for consideration. He does firmly believe, however, that it will most certainly pay in the long run to obtain in every case, whatever the method may be, at least as much information as was obtained, on the work described, as shown by the maps and profiles accompanying this paper.

Storage Batteries for Block Signals.*

With a transmission line a greater number of cells is necessary than for portable work and a somewhat larger generator. In the portable plan, on the other hand, we have a somewhat more expensive form of battery, due to the fact that it is necessary to install a larger size of cell and to use rubber jars instead of glass. In addition to this, we have in some cases the extra expense of transporting the cells.

The Southern Pacific Company has been using storage batteries in signal work for several years. For the automatic signals between Truckee, Cal., and Sparks, Nev., there are 66 signals operated from 41 battery locations. Each battery set consists of four cells of type 5-PV Exide, having a capacity of 55 ampere hours and eight volts. These four cells are mounted in two wood cases, two cells to each case, handles being provided, so that they can be readily transported. Each case of cells weighs approximately 25 pounds. These four cells, connected in series, are used for one signal, or for a pair of signals, provided they are not farther apart than 500 ft. Once a month the cells are placed upon a car and returned to the charging station, inspected and re-charged. It is customary to charge these cells in sets of seven, four cells to each set, making 28 cells in all. The charging station is at Truckee. The division of approximately 38 miles has four signal maintainers and a foreman.

There are 41 locations, with four cells at each; total 164 cells, supplying 66 signals, or approximately 2½ cells in operation per signal. Ordinarily 56 extra cells are kept in the charging station to exchange for others when they become discharged, making a total of 3½ cells per signal; or approximately six cells per mile of track. It is estimated that it costs 10 cents per k.w. hour for charging the batteries, which is less than $1 for each set of four cells per year, or $55 per year for the 55 sets. The cost of the charging station is approximately $300. This figure is exclusive of the building. In general, a small charging plant can be placed in a portion of a building already constructed and used for other purposes. A gas engine is used to drive the generator. A comparison therefore will appear as follows:

First Cost:	
1,056 primary cells at $2.50	$2,640.00
Cost per mile of single track	69.50
220 storage cells	1,200.00
Charging plant	300.00
Total	$1,500.00
Cost per mile	39.50
Increase of primaries over storage	.75 per cent.
Maintenance:	
On 1,056 primaries for 1 year	$1,056.00
Per mile	27.80
On 220 storage cells for 1 year	200.00
Charging current for 1 year	55.00
Total	$255.00
Maintenance per mile	6.70
Increase of primaries over storage	317 per cent.

The above figures show the relation between the operating costs of the two methods, since labor is the same in both cases.

As four cells of storage battery replace 16 primary cells, there is a corresponding reduction in the number of connections and of units requiring attention. Within the past year there have been but very few failures due to the storage batteries, and these were generally due to broken jars or carelessness in placing a discharged cell in service. Another advantage for the storage cell is the difference in available capacity. It may happen that one semaphore, for some reason or other, is worked a great number of times within a short period. In a case like this, the signal, after a number of movements, will work very slowly, or possibly not at all. This is of course due to the polarization of the primary cells, but with the storage cell operation is always sure.

In the Reading plant at Philadelphia the batteries, battery panels, engines and generators, switchboard and wiring, cost $2,300. As a return upon this investment it was figured that $2,100 annually would be saved in cost of maintaining the old primary batteries. From this should be deducted the maintenance charge on the present installation. This was taken at 10 per cent., or $230 annually. Deducting this from the gross saving, we have a net saving of $1,870. The storage battery installation was credited with 75 per cent. each for the old 1,203 primary cells displaced. This amounts to $902 and reduces, therefore, the net investment on the present apparatus to approximately $1,400. It will thus be seen that the estimated saving produced by the battery amounts annually to approximately 135 per cent. of the initial investment.

On the Illinois Central between Fulton and Central City, 100 miles, they have 23 operating stations. The line is a single track and a double arm semaphore is used, one for each direction. The semaphores are normally at danger, and are worked mechanically by the operator, but only at such times as he can get current from the battery situated at the adjacent signalling station. The battery provides current for signalling between stations and for unlocking the semaphores. It takes $^1/_{10}$ of an ampere, for one-half minute at the outside, to operate the magnet circuit; and as each battery works two semaphores, and there are 25 trains each way every day, this would mean .83 ampere hours per day, or 26 ampere hours per month. This is very liberal, as the time required to throw the semaphore after the battery is closed is nearer ¼ minute than ½. The portable batteries which are used have 33 ampere hours' capacity. Ten of these cells are used at each station, and charged once each month. Since the above estimate of ampere hours required for service is most liberal, it will be seen

*Abstract of a paper read before the Railway Signal Association at New York, Jan. 10, by E. L. Reynolds. Mr. Reynolds described the storage battery plants of the Philadelphia & Reading in Philadelphia, and of the Pennsylvania between Philadelphia and Downingtown. These were described in the *Railroad Gazette* of Nov. 11, page 548, and we omit this part of the paper.

that the cells have a considerable reserve capacity.

It is of great importance that the operating men thoroughly understand the best method of inspecting and operating the cells. With the cells used in permanent locations and charged over a transmission wire, the following suggestions are made for inspection and operation:

At each battery location there will be duplicate sets, one being used on the discharge while the other is being charged. One representative cell at each location will be termed the pilot cell. The level of the solution in this cell should be kept at a fixed height, ½ to ¾ of an inch above the tops of the plates, by the addition of small quantities of water, as necessary. This pilot cell should be used for frequent readings, described below. From this cell the condition of the other cells in the same series is judged. The above, of course, applies to conditions where there are several cells in series on each set. In those cases where there is but a single cell used for operation, as is very often the case in the base of semaphores, the readings should be of course taken upon that cell.

Charging.—It is of the utmost importance to have a considerable reserve capacity in the battery, and the battery should be charged at very frequent intervals. For example, on the Pennsylvania between Broad street and Downingtown, although the cells have a sufficient capacity to operate the signals continuously from five to eight days, it is customary to charge each day.

As not all sets are equally discharged, some will require a longer time for recharging than others. Where it is possible to do so, the cells which first come up to charge should be cut out, and thus prevent their overcharging. Where this is not practicable, the entire series of cells on charge should be cut out from the charging circuit when that set of cells which has done the greatest amount of work has been charged, and care should be used to prevent prolonging the charge beyond this point. During these frequent charges it is advisable not to charge the cells up to their maximum, but to cut off the charging current when the density of the solution has risen to within about three points of the maximum. Once a week, if the cells are charged every day, this charging current should be prolonged for about one-half to three-quarters of an hour after all of the cells have reached their maximum specific gravity. During the charge the specific gravity of each cell gradually rises until it has reached the maximum point, when the battery is filled. After this point there is no further increase in the specific gravity. Corresponding with this maximum point in density, the maximum voltage of each cell is reached.

Discharging.—Storage cells should always have considerable reserve, so it is inadvisable to entirely discharge in service. Then it is not necessary to keep any special watch of the specific gravity on the discharge, provided it is known as a positive fact that the cell is not being used to the extent of its entire capacity. The fall in specific gravity during discharge below the maximum point should not be greater than 15 or 20 points in ordinary operation. At the end of each charge and discharge, the specific gravity of the pilot cells should be read and recorded, together with the temperature of the battery room and the electrolyte. On the day before the weekly overcharge, the specific gravity of each cell in the set should be read and recorded, after the regular charge is finished.

Chicago Railway Terminals.

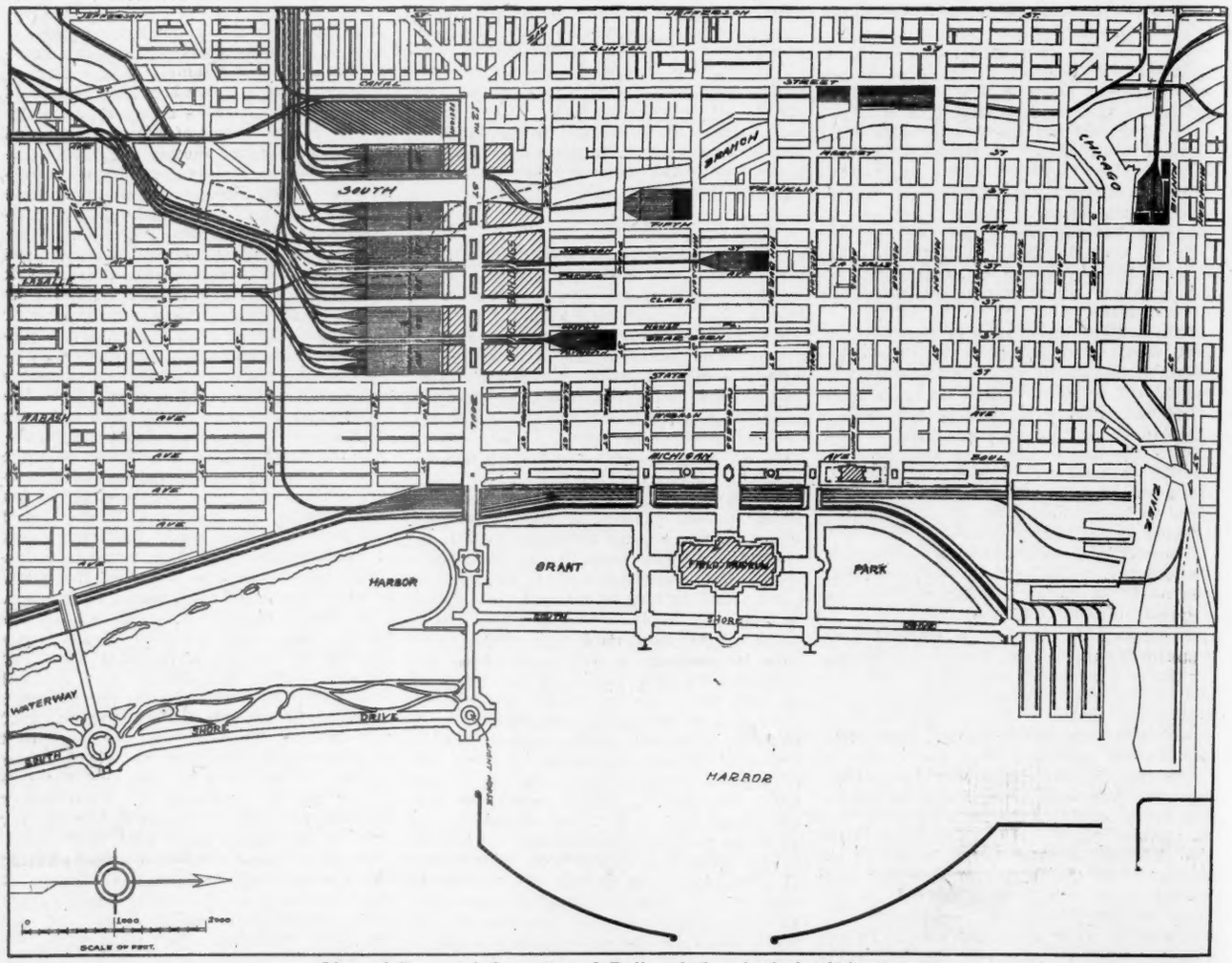
BY FREDERIC A. DELANO.

The 22 trunk lines having terminal facilities in Chicago have their passenger terminals at six different centers, as follows:

(1.) The Chicago & North-Western on the north side at Kinzie and Wells streets, a location convenient to the north side of Chicago, but not convenient to a large part of the business center, nor to the west or south sides.

(2.) The Union Depot at Canal and Adams streets, where the Chicago & Alton, Chicago, Burlington & Quincy, Chicago, Milwaukee & St. Paul, and the two Pennsylvania Lines have their terminals. This depot is conveniently located for the west side, and is reasonably near the business center, but is not convenient for the north nor for the south side residents, as they cannot reach it by cars without a change.

(3.) The Grand Central Station at Harrison street and Fifth avenue, where the Baltimore & Ohio, Chicago Great Western, and Pere Marquette roads have their terminals.



Plan of Proposed Grouping of Railroad Terminals in Chicago.

This location is sufficiently near the business center, but is inconveniently situated for street railway facilities from either north, west, or south sides.

(4.) The Lake Shore-Rock Island Station, at Van Buren and La Salle streets, where the Chicago, Rock Island & Pacific, Chicago & Eastern Illinois, Lake Shore & Michigan Southern, and New York, Chicago & St. Louis roads have their terminals. This station, being on the elevated railway "loop," is, from a city transportation standpoint, best located, both for the business center, and for the north, west, and south sides.

(5.) The Polk Street (Western Indiana) Station, at the intersection of Polk and Dearborn streets, where the Atchison, Topeka & Santa Fe, Chicago, Indianapolis & Louisville (Monon), Erie, Grand Trunk, and Wabash roads have their terminals. This station is rather poorly located for the business district. The transportation facilities connecting with the north and west sides are very bad, and even from the south side it cannot be reached directly.

Part End Elevation of Proposed Group of Headhouses Facing Twelfth Street.

(6.) The Illinois Central Station at Twelfth street near Michigan avenue, at which the Cleveland, Cincinnati, Chicago & St. Louis, Illinois Central, Michigan Central, and Wisconsin Central roads have their terminals. This station is convenient for the residents of the south side, but not for residents of the north and west sides, who can only reach it by changing cars. It is near the hotels, but not near the present business center of the city.

One must be familiar with the street and elevated railway transportation facilities to estimate the relative convenience of these depots, and to understand the inconvenience which through passengers going from one station to another have to encounter. Every student of the present railroad conditions in Chicago must know that to improve the facilities at each of these important centers will before long necessitate a very large expenditure of money. In the case of several of the depots, the value of adjacent property and the position of existing thoroughfares makes it almost impossible the enlarge the station, and no matter how large the expenditure, the inconvenience involved in reaching some of the stations, or of going from one station to another will remain. This is the case because they are so placed that they cannot be reached by the lines of traffic radiating from the business center to the north, west, and south sides without a change of cars, while no simple transportation facilities can be arranged to connect all stations. As a result, a very large sum of money is annually expended by the railroads for the transportation of passengers, baggage, mail, and express from one depot to another.

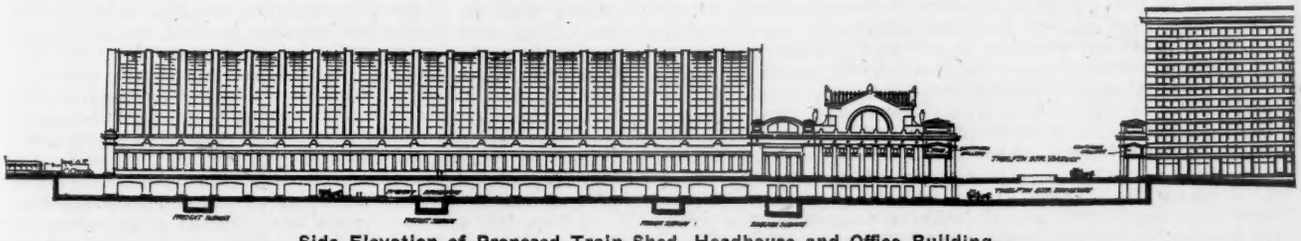
Some of these drawbacks could be entirely overcome, and valuable advantages gained if a site could be found where these six groups of railroads could establish their termini on one street, side by side. Such a location exists at Twelfth street,* or at Taylor street, some 800 ft. further north, which further investigation might prove more desirable. In both cases the railroads already own all the property between State street and the river, and most of the property between the river and Canal street. The street on which the proposed stations would be located (Twelfth street, for example) should be made 150 to 200 ft. wide so as to compare favorably with any of the great boulevards of the world. Such a boulevard approximately on the level of the present viaduct, provided with an elevated railroad and ample drive-ways and electric car tracks in each direction, would intersect all the north and south transportation lines, and would make a direct highway through the heart of the west side. Moreover, an elevated road, operating with shuttle trains, could readily be constructed to connect the south side system at Twelfth street with the west side system near Halsted street.

The idea contemplates bringing in the passenger tracks say 20 ft. above the present surface and slightly above the viaduct level, utilizing the entire space beneath them from Twelfth to Fourteenth streets, and from State street to the river, and, if needed, west of the river, for handling on the present ground level, baggage, express, mail, and less than carload (L. C. L.) freight. The proposed depots, five of which would be located east of the river (and, when needed, one in addition west of it), would be separated from each other by the streets running north and south, some of which would be elevated. State street and Wabash avenue would run through as now, while Clark street and Fifth avenue would be raised to the level of the viaduct at Twelfth street, and would come down to the present grade again in the neighborhood of Sixteenth street. The space under these streets would be utilized in some cases for railroad tracks, in others for teams to reach the freight houses, and at the extreme south end, under the diminished head-room, as a convenient means of connecting these freight houses by passages for the trucking of freight. Subterranean galleries running east and west at convenient intervals between Twelfth and Sixteenth streets, and reached by elevators, would also connect the warehouses for the handling of baggage, express, United States mails, and L. C. L. freight, so that not only would the entire story on the boulevard level be used for passenger business, but the present ground level would be assigned for the handling of baggage, express, mail, and freight. In this freight warehouse, facilities would be given for handling less-than-carload interchange business in a way that has been many times suggested, but never satisfactorily worked out. This less-than-carload interchange is now accomplished either by loading cars with miscellaneous shipments which have to be switched and rehandled, involving expense and delay in transit; or by teaming, which is more rapid, but more expensive. A still further advantage would be that on the western edge of this immense freight warehouse the river frontage would give facilities for delivering to the railroads all freight handled by lighters or steamers, so that all the merchants in the city having water frontage, could receive or make deliveries of their freight to or from any railroad by this method.

The plan, as thus far worked out, contemplates changing the course of the river between Twelfth street and Sixteenth street. At this point the river now bends abruptly toward the lake, and then back again to the west. This scheme proposes to make a new channel straight south, thus putting on the east side of the river property which is now on the west side, making the river more readily navigable, and securing thereby the cooperation and assistance of the drainage board.

The accompanying drawing shows the map of Chicago with the proposed depots, with the widened driveway, and on the west side with suggested boulevards to the northwest and southwest, and so provide better and more direct connection with these new terminal facilities. It also shows the straightened river just mentioned.

The other drawing is a north and south cross-section, through Clark street, giving a view of one of the stations with a head-house facing on Twelfth street. It shows clearly the relation of the Twelfth street viaduct and the north and south streets to the railroad termini; also the use to be made of the space underneath the passenger tracks.



Side Elevation of Proposed Train Shed, Headhouse and Office Building.

As an engineering proposition this plan presents no serious difficulties, and, in fact, makes possible the elimination of some which now exist, because if the arrangement were made with the common consent of all the roads concerned (and it could not well be made otherwise), a regrouping of the railroads would then be feasible which would almost entirely unravel the bad snarl of crossings at Clark and Sixteenth streets, and at Archer avenue and Twenty-first street. The real difficulty in the situation is, obviously, that of bringing together the more or less discordant interests. It is recognized that some companies, seeing their advantage under present conditions over their neighbors, may be unwilling to give up that advantage, even though the new arrangement offers some attractive features. But, perhaps,

*Hereafter in this discussion the plan in its relation to 12th street alone will be considered, with the understanding, however, that in a general way all that is said about 12th street will apply also to Taylor street.

when the matter is studied carefully, proper means of reconciling these differences will be found. It certainly is not the intention of the writer to belittle such difficulties, but simply to direct attention to what appears to be a very remarkable opportunity of straightening out a rather bad situation. Chicago, already the greatest city in the middle west, destined, in the opinion of many, to be the greatest city of the world, has here a chance of making for itself an ideal railroad entrance. It is recognized that no one union station can accommodate the volume of traffic; it is recognized further, that there is such a thing as making a union passenger station too large; but the proposed plan of placing five or six units in convenient relation to each other, and in practical juxtaposition, units which together will serve not only the passenger business, but to a very important extent the freight business of the city, is surely a move in the right direction.

The plan, too, is susceptible of considerable expansion, because in the location suggested there is no doubt that between State street and the river as straightened, more than double the present facilities could be provided, with all the space between the river and Canal street for future expansion. But the one fact above all others which makes it possible is, as stated above, that practically all of the property is already owned by the railroad companies. There is the further advantage that the existing improvements upon it are not of great value, and could be readily replaced elsewhere.

The plan does not require its immediate adoption by all roads; it would not be proposed, for example, to disturb those now running into the Illinois Central station. They would continue to use their present terminal and be connected with the proposed station by adequate subways. It would be possible (though perhaps not desirable) for the roads in the Grand Central, Polk street, and Lake Shore-Rock Island stations to run their trains through the proposed new depot, of course under the viaduct level, into their present terminals. The roads using the Union station could do so until they were ready to use the new one, and obviously the C. & N. W. could still utilize its present terminal. But, as may not be generally known, that company owns a right of way along Sixteenth street from the west that would give its Omaha line ready entrance to the proposed station. Then a connecting link parallel to the C., M. & St. P. from Mayfair Junction to Western avenue and Kinzie street would make the same route feasible for the Wisconsin and Milwaukee divisions.

The C., M. & St. P., already a tenant of the Pennsylvania Company, for its trackage facilities east of Western avenue, could reach the new station by its present route, i.e., through the Union depot, or could without doubt find another and more direct way.

However, it is not essential to the success of the plan that the Chicago & North-Western or the Chicago, Milwaukee & St. Paul should participate in it. These roads might prefer to join in a station on the north or west sides, but all other lines entering the city come in from the south or from the west south of Fifteenth street, so that the location suggested is obviously the most convenient for them.

It may be argued that for suburban traffic the present downtown terminals cannot be abandoned, nor does this plan require it. Under it, both the Illinois Central and the North-Western roads (which have the largest suburban business) would continue, undoubtedly, to use the same arrangements for their suburban traffic as they now do. Whether the other roads doing a suburban business could or would find it desirable to run trains to their present terminals need not be settled now.

It cannot be seriously contended that the proposed railroad center will be too far from either the business or the geographical center of Chicago. Ten years ago this might have been so, but conditions are rapidly changing and the business center of the city, limited by the lake on the east, and the river on the north and west sides, must move southward.

An analysis of the advantages of the proposed scheme to passengers using through trains in contra-distinction to suburban trains may be of interest in this connection. They may be classified as follows:

(*a*) Passengers continuing their journey by other roads will be better served by the juxtaposition of the different railroad depots.

(*b*) Passengers living in Chicago who wish to arrive and go to their homes will be equally well or better served.

(*c*) Passengers going to hotels in the city by street cars, bus, cab, or carriage, will be equally well if not better served at Twelfth street, the location being nearer the hotel center than most of the existing depots.

(*d*) Business men entering or leaving the city and wishing to go directly to or from their offices would surely on the whole be as well off as at present, for the proposed group of depots would be served by five north and south arteries, and have direct elevated railroad connections with the west side.

The idea contemplates that on the north side of the proposed Twelfth street boulevard the railroads would erect opposite their passenger depots office buildings adequate for all their needs, giving themselves office room which would be cheaper than they could get elsewhere, which would be convenient for the public desiring to do business with the railroads, and so accessible for railroad officers and employees as to be most desirable.

An improvement in the present situation is very much needed; perhaps more needed than any realize. The extent to which people are actually driven away from Chicago by the aversion they feel for the city, growing largely out of what they see of it as they enter or leave it, means a serious loss. Some one has well said that the gateway of a large city is its railroad terminal, and from this gate the great majority gain their impressions. What has already been done in European capitals, and in this country in some of our larger cities hardly needs to be referred to. By co-operation of the railroad companies, the municipality, and public-spirited citizens, the railroad terminals in Boston, which for a long time were anything but a credit to that city, have been brought up to a high and creditable standard. Immense sums are at the present time being spent for this purpose in New York City and in Washington, and a number of other large cities have large and comprehensive plans in view. Chicago, the leader of them all in importance as a railway terminus, cannot afford to remain behind.

A difficulty in the problem, and one not to be overlooked, is that to carry out the plan in its entirety necessitates a readjustment of ownership in much of the real estate concerned. In all probability the best way would be to pool all property involved within the limits indicated, placing it in the hands of a single large corporation, which would issue securities to the present owners, and be in a position to raise sufficient money to carry out the plan.

No very definite estimate has been attempted as to the cost of carrying out this scheme; the expense will, obviously, vary with the details of the plan as adopted, but it is thought that, exclusive of the land, $75,000,000 would cover the entire cost. On the assumption that the roads using the Illinois Central terminal would remain where they are, and that the other 18 companies would come in, this does not seem a very serious burden, and as already suggested, the sale of the property north of Taylor street and the use of the space over the tracks north and south of Twelfth street for office buildings would to a considerable extent offset this expenditure. Moreover, while as a general proposition it may be a mistake for a railroad company to part with valuable inside property, it would be of great advantage to Chicago if the property now so largely held by the railroads between State street, the river, and Van Buren and Taylor streets could be added to the business center of the city.

In conclusion it is perhaps unnecessary to state that to carry out a plan so large and comprehensive requires the co-operation of all the business interests involved. The railroad interests—that is, not only the companies that control the property, but those that are tenants—must act in harmony, while in addition, the co-operation and encouragement of the leading citizens and fair consideration at the hands of the city government to grant the necessary ordinances and authority are indispensable.

This scheme is not offered or backed by any railroad company. It is simply a personal suggestion on the part of one who has studied the problem from an engineering and operating standpoint. It is submitted as such for the consideration of those who are in a position to carry it out.

The writer is indebted to Mr. D. H. Burnham and members of his staff for the plans forming part of this paper, and to him as well as to other friends for encouragement in the matter.

The Regulation of Railroad Rates.

BY HON. MARTIN A. KNAPP.

The purpose of this paper is merely to outline without elaboration the questions involved and the principles to be applied in the regulation of railroad rates by public authority. If any argument is needed in support of the right and the duty of Government control, it is found in an obvious and fundamental fact. Until modern discovery utilized steam as a motive power, the ordinary public road was the sole means of communication by land, the only pathway of internal commerce. Before this new agency was brought into service, while the old highways were yet exclusively employed, the right to their common use was nowhere doubted or denied. In recent times certainly—and this is the point of importance—the established roads, the strips of land set apart as ways of passage, have everywhere been regarded as common property, and the right to their common use has been the recognized and equal possession of every person.

But the transfer of land commerce to highways of steel, with the substitution of steam and electricity in the place of animal power, has not impaired the nature of this right or diminished in the least its inestimable value. On the contrary, there is no pursuit or employment which is not now more dependent than ever before upon the means provided for public transportation. The railroad has become the principal highway. For long distance movement it has wholly supplanted the public road, yet it performs on a much greater scale the same governmental function and meets the same increasing and indispensable need. Hence, the railroad of to-day, this wonderful vehicle of modern commerce, has become the chief factor of industrial life, the *sine qua non* of its power and progress, the primary condition on which individual opportunity and wel-

fare continually depend. The right to just and equal charges for railroad service springs therefore from the nature and necessities of social order. The railroads are an agency of the state for discharging a public duty of the highest utility. The right to use their facilities, like the right to the common highway, is an inherent and inalienable right the very essence of which is equality.

To secure the full enjoyment of this right, to enforce reasonableness and impartiality in the conduct and charges of railroad carriers, is the distinct and beneficent aim of all regulating measures. The ideal condition obtains when the facilities of transfer are furnished on fair and actually equal terms, so that no advantage to one person over another, or to one community or commodity over another, is gained or expected in the use or cost of the agencies of transportation.

Now, whatever plan is adopted for accomplishing this purpose, it is evidently needful, as a practical measure, to provide at the outset a legal standard of compensation binding alike on those who furnish and those who employ the instrumentalities of public carriage. In other words, there must be a fixed and common rate, made known by suitable publication, which constitutes while it remains in force the measure of lawful charges. In the nature of the case, as it seems to me, this is necessarily the first step in the regulation of rates and charges.

Starting then with the standard legally established, whether by the carriers themselves as is now the case or by the exercise of public authority in the first instance, two difficulties at once arise. These difficulties are quite distinct in nature and differ widely as to the appropriate means by which they may be overcome. One relates to the measures for securing uniformity to the standard rate, the other to the methods by which the standard itself may be changed or its reasonableness tested. These are practically unlike purposes. To accomplish them both requires efficient but dissimilar action. It is one thing to prevent the wrongdoing effected by granting to favored persons some discount from established charges, no matter in what way the preferance may be secured; it is quite another thing to correct the wrong-doing which results from excessive or relatively unfair rates, though properly published and strictly enforced. This important distinction—between offenses like secret rebates and kindred practices on the one hand and injustice resulting from the operation of the published rate itself on the other—is frequently overlooked. For this reason doubtless there is much misconception both as to the provisions of existing laws and as to the power of Congress to legislate upon the subject.

The nature of the distinction here pointed out and the importance of its recognition are made apparent when once the practical aspects of the matter are clearly perceived. It must be evident upon reflection that the only effective mode of dealing with those discriminations between individuals which are effected by rate cutting, rebates, underbilling and the like, is to place them in the category of criminal misdemeanors. No other direct and suitable remedy can be provided by legislative enactment. Any redress for injuries of this sort through civil actions for damages, which is the only alternative, is manifestly of insignificant value. It neither affords compensation to those who have suffered nor does it operate with any force to prevent the recurrence of such misconduct. For offenses of this class are not the mere disregard of contract obligations; they are infringements of the common right and violations of unquestioned public duty. But when transgressions of this kind are made amenable to the criminal law, when the statute has impressed them with this penal character, they must be dealt with in the same manner and by the same agencies as other punishable offenses. As respects their prevention or the methods by which those who commit them may be prosecuted, they differ in no material respect from other misdemeanors. The ordinary machinery of the criminal law must be employed against those who transgress in this manner, and there is no other way by which penal provisions can be made effective.

It is scarcely necessary to observe that an administrative body, like the present Commission, is wholly without authority to prevent this species of discrimination. True, such a tribunal may be charged with the general duty of executing and enforcing the law; but it cannot be endowed with the power to punish delinquents or to otherwise administer the criminal remedies provided, except as it may aid prosecuting officers in procuring evidence against suspected parties. Plainly, if immunity is secured from these vicious practices it must be sought in the means devised for the enforcement of other criminal laws, and by the adoption of a legislative policy which shall remove or minimize the inducement to criminal wrongdoing.

It is worthy of remark in this connection that these are preventable evils. They are the natural outgrowth of conditions and theories which have largely obtained in railroad operations, but they are rapidly disappearing and will soon, I am sure, become as rare and as relatively unimportant as highway robbery and other like offenses. Their existence, to the extent they may continue, will not be a serious element of the railroad problem, as their suppression is only an incidental feature of the task of regulation.

If these views are correct, it becomes apparent that the principal and permanent office of regulation concerns itself not with secret or prohibited departures from the public standard, however established, but with the reasonableness and justice of the standard itself and the means of bringing about its alteration whenever found excessive or inequitable. When the effort at Government control was first undertaken, there were, as now, tariffs in general use which furnished, nominally at least, the basis for computing the carrier's charges. These rates are fixed by the railroads themselves and represent their notions of proper or obtainable remuneration. The great body of producers and consumers, whose interests are so vitally affected by the cost of transportation, and who are so completely dependent upon this public service, have no voice in determining these charges and little power to prevent exactions or inequality except as they may command the intervention of public authority. If the tariffs in current use are filed and published as the law now requires, and as any useful and workable law must necessarily require, they furnish a standard of charges *prima facie* lawful and binding both on the railroads and the public. So long as they are actually observed nobody presumably is injured and nobody at fault. But if those upon whom these rates are enforced complain that a given rate is too high or is relatively unjust, and that charge is denied by the carrier concerned, how is the controversy to be decided? Are railroad managers themselves to be the sole judges of the reasonableness of their own rates? Are they to be the final arbiters of the just relation of rates between different commodities and different communities? To investigate these tariffs, made as they are for the most part by the railroads themselves and in their own interest, to compel their correction when found to be oppressive or unfair, to determine in such cases what are just and reasonable rates for public carriage, is a governmental function of the highest utility. This is the central idea of regulation and the permanent field of its usefulness. Some authority there should be, superior to and independent of the carrying corporations, to examine their schedules, prevent unjust exactions, and equalize so far as may be the burdens of transportation. More and more, as population increases and industries multiply, will these burdens demand unbiased scrutiny and equitable readjustment. To give each community the rightful advantages of location, to keep different commodities on an equal footing, so that each shall circulate freely and in natural volume, to make the avenues of distribution and exchange equally available to all producers, so that none shall be overweighted by discriminating rates or oppressive charges, to settle such controversies as may arise between the carriers and the public with due regard to the interests of both; all this, as it seems to me, is comprehended in the needs and aims of public regulation.

That legislation to this end is a valid and appropriate exercise of the constitutional power possessed by Congress has repeatedly been declared by the highest judicial authority.

In the notable case of Ames vs. Union Pacific Railway Company (64 Fed. Rep., 178) Mr. Justice Brewer uses the following language:

"Within the term 'regulation' are embraced two ideas: One is the mere control of the operation of the roads, prescribing the rules for the management thereof—matters which affect the convenience of the public in their use. Regulation, in this sense, may be considered as purely public in its character, and in no manner trespassing upon the rights of the owners of railroads. But within the scope of the word 'regulation' as commonly used, is embraced the idea of fixing the compensation which the owners of railroad property shall receive for the use thereof."

Under this decision and others of equal significance, it may be regarded as definitely settled that, within limitations which preserve to the owners of railroad property the equal protection of the laws and prevent the taking of such property without due process of law, the power of Congress—either by direct action or through the medium of a commission—to prescribe from time to time the scale of charges for the carriage of interstate commerce is in every respect plenary and exclusive. The wise exercise of that power within those limitations, for the purpose of enforcing transportation rates which are reasonable and relatively just, is at once the most important and the most needful in the whole field of national legislation.

Obviously, the investigation of published rates which are the subject of complaint and the alteration of the established standard, when that standard is found to be actually or relatively unjust, are matters unsuited to the application of penal statutes. The carrier which fixes in good faith and impartially applies a schedule of rates cannot be regarded as a criminal offender merely because that schedule is believed or afterward found to be excessive in amount or prejudicial to one locality as compared with another. These are questions concerning which there may be and often is an honest difference of opinion, and until a new standard is in some way authoritatively fixed the collection of charges according to the old standard affords no ground upon which to base a criminal charge. The demands of justice

in such cases would not be satisfied if criminal liability could be predicated upon the observance of a standard rate, although claimed to be unjust, before a new standard was in some way prescribed. In other words, there must be a proceeding in the nature of a judicial inquiry or the alteration of the open tariff by voluntary action or the exercise of public authority.

Nor can the correction of excessive or preferential rates be secured through the ordinary courts. Not only are their methods and rules—however necessary to safeguard the adjudication of private controversies—unsuited to the determination of public rights as affected by transportation charges, but the limitations upon their powers preclude them from granting the measure of relief which the nature of the case requires, and that is the substitution for future observance of a new standard of charges. If the rates in force are too high or relatively unjust, the only remedy of practical value is a reduced or readjusted schedule to be thereafter applied. But this involves the exercise of legislative authority which courts do not possess and with which, under our form of government, they apparently cannot be endowed. Any substantial and adequate relief from inequitable rates must therefore be afforded through the medium of an administrative tribunal.

Such a tribunal, exercising by delegation some measure of the power vested in Congress, should have ample authority to determine in the first instance, and with at least the conclusiveness of a court of first instance, whether particular rates or practices, of which complaint is made and which are investigated upon notice and opportunity to be heard, are or are not in violation of the carrier's obligation to charge only reasonable and non-preferential rates. When such a question has been thus tried before that tribunal, its decision should stand as a rule of conduct prescribed by public authority and be observed as the just and legal standard of charges, unless a review thereof by the courts shall disclose some error which warrants judicial interference. It is not proposed that this tribunal shall establish schedules by arbitrary methods or be clothed with power to fix rates by *ex parte* orders; but it is proposed, when a given rate is complained of on the ground that it is excessive or relatively unjust, and that complaint has been examined upon due notice to the carrier and full opportunity to be heard, that the judgment of the tribunal in such case shall be binding upon all parties to the contention, unless judicial review finds cause for preventing its enforcement. The exercise of such authority when occasion requires, is the only appropriate and adequate safeguard against unreasonable or discriminating charges. Not in the award of damages for past injuries but in the substitution of a new and juster standard of compensation will be found the sufficient and comprehensive remedy for the wrong-doing occasioned by unreasonable rates; and nothing short of this answers the purposes or meets the needs of public regulation. Congress has not undertaken, probably will not undertake, to prescribe by specific enactment what rates shall be charged by any road or on any article of traffic. As a practical matter, its power in this regard must be delegated to an official body which shall determine and prescribe the rates and rate relations to be put in place of those found to be unreasonably high or to operate with discriminating effect. To guard against the abuse of such authority the action of the regulating body should be subject to judicial control under conditions suited to the nature of the controversy and designed to secure its just and speedy determination. In my judgment these are the principles which should govern the development of any suitable and sufficient scheme of railroad regulation. If these principles are accepted their application becomes a matter of detail which the limits of this paper do not justify me in attempting to discuss.

One inference from these views, however, may be properly suggested. The evils which have attended the growth and operation of our railroad systems, and which have given rise to so much public indignation, have their origin and inducement for the most part in the competition of carriers which our legislative policy seeks to enforce. That this is a mistaken and mischievous policy I am fully persuaded. So long as the competition between carriers remains unrestrained, just so long will it find expression, to an extent always serious and often alarming, in secret departures from the established standard and relative injustice in the standard itself. The power to compete is the power to discriminate, and it is simply out of the question to have at once the presence of competition and the absence of discrimination. To my mind the legislation which decrees that all rates shall be just and reasonable, and declares unlawful every discrimination between individuals or localities, is plainly inconsistent with competitive charges. The facts of experience and familiar knowledge demonstrate the error and futility of regulating laws which at once endeavor to make rate competition compulsory and at the same time condemn as criminal misdemeanors the acts and inducements by which in other spheres of activity competition is mainly effected. For this reason I advocate the legal sanction of associated action by rival carriers in the performance of their public functions. This is the one sensible and practicable plan, adapted to existing conditions and suited to the requirements of a public service. Such a policy would promote and invite the conduct of railroad transportation in the manner most beneficial to the people and the railroads alike.

The true theory of public regulation, therefore the theory which is best calculated to produce useful results, is to allow the railroads to unite with each other in the discharge of their public duties, thereby making it feasible and for their interest to conform in all cases to their published schedules, and to invest the regulating body with authority, after investigation of complaints upon due notice and hearing, to condemn the rates found to be actually or relatively unreasonable and to prescribe, subject to judicial review, a substituted standard to be thereafter observed. If these views are correct and grounded in sound public policy, their speedy adoption will enlarge the benefits and promote the success of railroad regulation.

Railroad Shop Tools.

(*Continued.*)

SHAPING MACHINES.

The accompanying illustration, Fig. 1, shows a snagging shaper made by the Perkins Machine Company, Warren, Mass. The tool is designed for heavy work, such as cutting off sprues on steel castings, locomotive driving boxes, etc. It has an 18-in. stroke and is fitted with the "Whitworth" quick return motion. The ram is 7 ft. long and the feed screw has a down feed of 8 in. The vise is of solid steel and the vise jaws are 24 in. wide with a maximum opening of 20 in. The vise screw is 2¾ in. in diameter. The cross head is 48 in. long and the cross feed is about 36 in. The tight and loose countershaft pulleys are 20 in. in diameter for a 4 in. belt. The worm gear is of bronze and is 22 in. in diameter. The floor space required for this machine is 5 ft. x 7 ft. by 5 ft. high, and the net weight is about 9,000 lbs. This machine can be furnished for either belt or electric drive and when electric driven a 2-h.p. motor is required.

Another heavy machine is the 34-in. geared shaper shown in Fig. 3 which is made by George D. Walcott & Son, Jackson, Mich. This

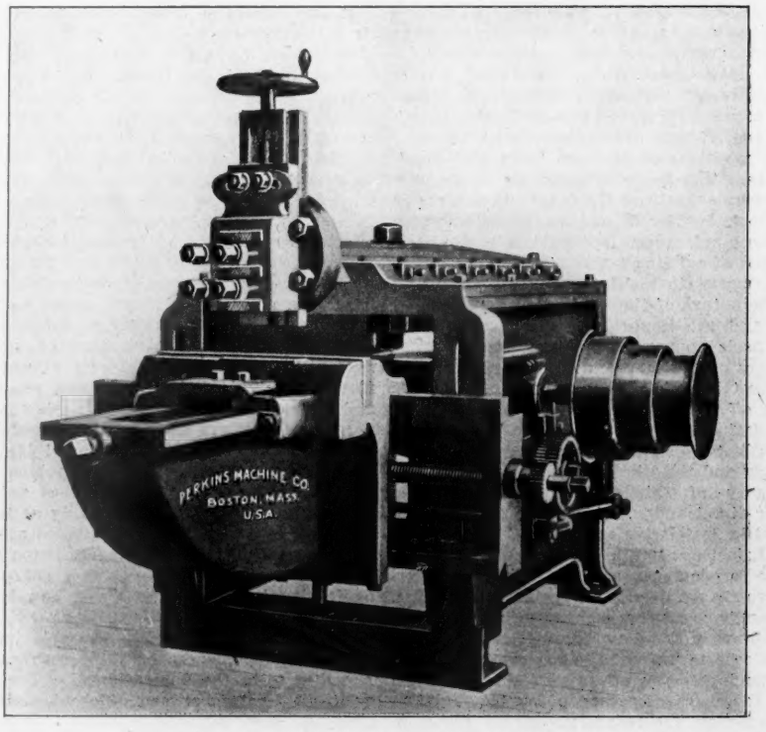


Fig. 1—The Perkins Snagging Shaper.

machine has a quick return motion, the cutting stroke is uniform throughout and the length of the stroke can be adjusted while the machine is in motion. The bearings for the ram are broad and project out over the table. An opening is provided under the ram for passing shafts through for key-seating. The cross rail has a square lock on the column and is provided with broad bearing surfaces. The platen bearings on the cross rail are deep and long and the top and back bearings extend on both sides. The angle plate is fastened to the platen by a solid lock and can be quickly removed to allow large work to be fastened to the platen. The tool head is graduated and swivels to 50 deg., and is firmly held in position by one bolt. The counter is arranged for two speeds—280 r.p.m. for cast iron and 180 r.p.m. for steel. The vise has a graduated base and can be swiveled to any angle. The maximum stroke of the ram is 36 in. and the length of the automatic cross traverse is 34 in. The greatest distance between the tool and the top of the table is 18 in. and the table top is 18 in. x 24 in. The face of the platen is 18 in. x 19 in. The diameter of the tight and loose pulleys is 12 in. for a 4-in. belt and the net weight of the machine is 4,200 lbs.

The 14-in. driving box shaper shown in Fig. 3 is made by William Sellers & Company, Philadelphia, Pa. It is a massive and substantial machine and is especially designed for planing out the semi-circular bearing in locomotive driving boxes, preparatory to placing the brass bushings. The distance between the ribs on the knee for holding the work is 26 in. and the knee or table is provided with a cross travel on the bracket which has a vertical adjustment of 8 in. The cutter bar has a quick return motion, its stroke is adjustable and its maximum travel is 14 in. The cutter bar is also provided with an automatic circular feed. Fig. 4 shows a tool for planing the straight sides of locomotive driving boxes. This machine is generally used in connection with the machine shown in Fig. 3. It has a maximum stroke of 14 in., is provided with quick return motion, and will take in work 20 in. wide. The knee has a cross travel on the bracket and the tool holder has a stroke of 8½ in, and is provided with an automatic vertical feed.

(To be continued.)

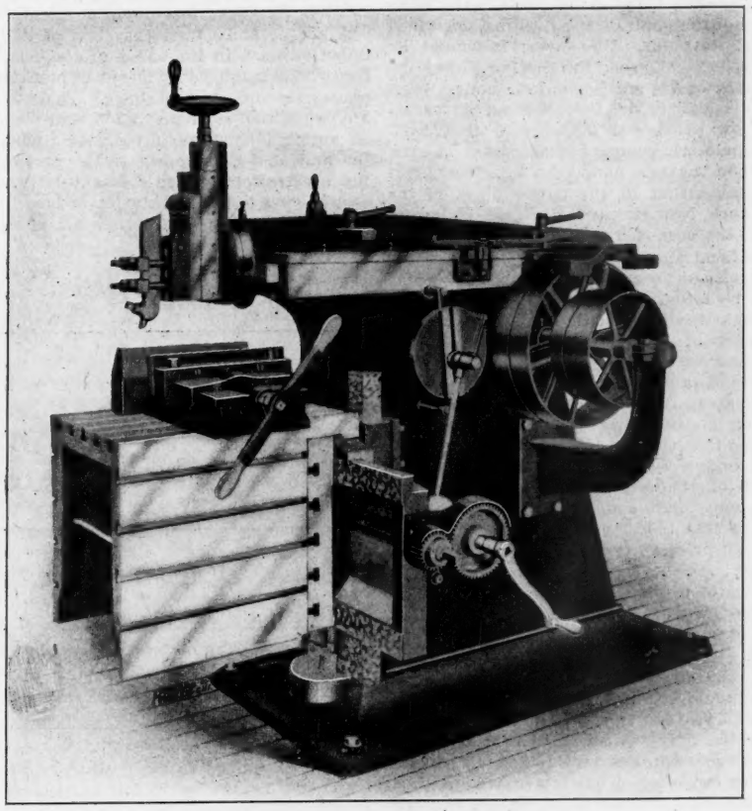


Fig. 2—The Geo. D. Walcott Shaper.

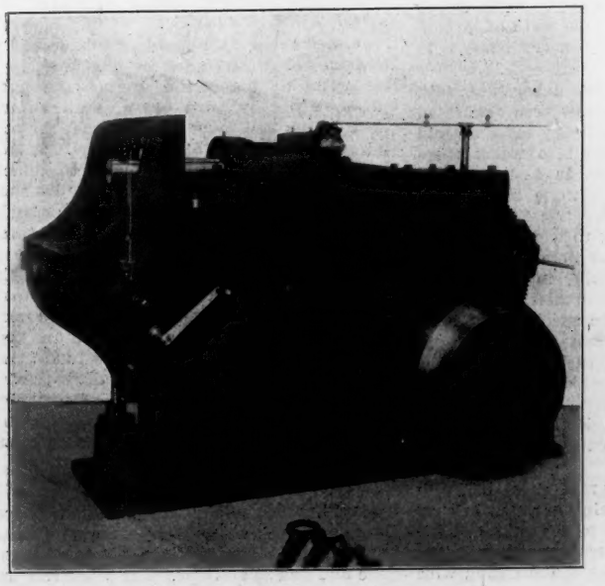


Fig. 3—The Sellers Driving Box Shaper.

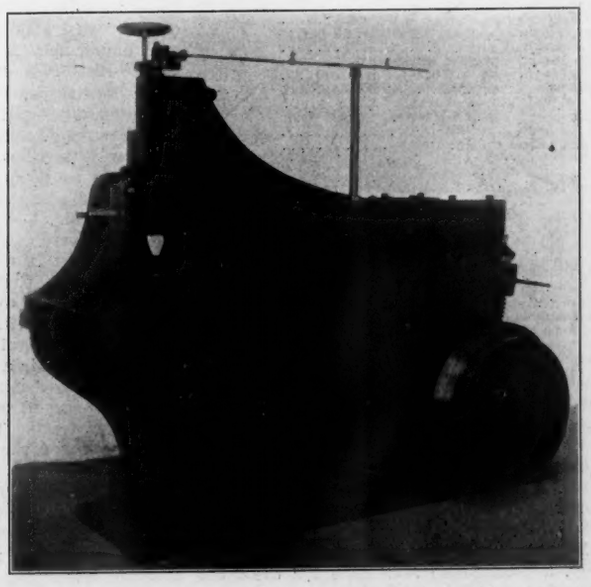


Fig. 4—The Sellers Driving Box Shaper.

The Railway Signal Association.

The January meeting of this association was held in New York City last Tuesday afternoon. President J. C. Mock occupied the chair, and the Secretary was H. S. Balliet, Secretary of the association. About 60 members were present and 13 new members were elected.

The Secretary of the American Section of the International Railway Congress has requested that this and other associations take care not to have meetings in the month of May which will interfere with the Congress to be held in Washington in that month. After some discussion of this request the executive committee was instructed to take such action as may be found desirable in regard to changing the date of the May meeting; and to have it held in the city of Washington, if found expedient.

The principal discussion was on a paper by Mr. E. L. Reynolds on Storage Batteries for Signals, an abstract of which will be found in another column.

Mr. Anthony, answering a question concerning the storage battery plant on the Pennsylvania, described by Mr. Reynolds, said that no exact comparison had been made between the cost of operating that plant and of running a similar number of signals by portable batteries, to be carried in the cars to and from charging stations; it had been assumed at the outset that such transportation of batteries would be undesirable. A

number of members asked for information as to the cost of a charging wire as compared with portable batteries, but neither Mr. Reynolds nor any member had data which would apply to more than one case; each case must be considered by itself.

Mr. Rosenberg, Signal Engineer of the Lehigh Valley, criticised the comparisons made in Mr. Reynolds's paper as in some degree misleading; as, for example, in giving the cost of a generator station too low and omitting any charge for transportation of portable batteries. Mr. Rosenberg gave the following statement of the cost of working signals by primary batteries on his road for the year ending June 30, 1904.

FOR ENCLOSED DISK SIGNALS.

Number miles protected	562
Number blocks	578
Average length of block, mile	.97
Signals	1,156
Track, cabin and gatehouse indicators	705
Blocks with indicators	295
Blocks without indicators	283
Cells, track battery (bluestone)	2,312
Cells, signal battery (caustic soda)	12,716
Cost per cell, track battery, per year	$2.08
Cost per cell, signal battery, per year	0.6823
Average cost of indicators, per year	5.98
Summary:	
2,312 cells, track battery at $2.08	$4,809.96
12,716 cells signal battery at .6823	8,676.96
705 indicators drawing from signal battery	4,216.99
	$17,703.91
Average cost for signal battery per mile	$15.44
Average cost, indicator battery, per mile	7.50
	$22.94

FOR ELECTRIC MOTOR SIGNALS.

Number miles protected	325
Number blocks	249
Average length of block, miles	1.3
Signals, number	498
Track, cabin and gatehouse indicators	219
Blocks with indicators	107
Blocks without indicators	142
Cells, track battery (bluestone)	1,300
Cells, signal battery (caustic soda)	6,474
Cost per cell, track battery, per year	$2.08
Cost per cell, signal battery, per year	.725
Average cost, indicator battery, per year	5.54
Summary:	
1,300 cells, track battery at $2.08	$2,704.00
6,474 cells, signal battery at .725	4,697.46
219 indicators, drawing from signal battery	1,214.38
	$8,615.84
Average cost for signal battery per mile	$14.45
Average cost, indicator battery, per mile	3.73
	$18.18

Following this statement Mr. Rosenberg gave an estimate which he had made of the probable cost of working the same signals by storage batteries (portable cells) as follows:

FOR ENCLOSED DISK SIGNALS.

4 charging stations at $500	$2,000.00
4 complete charging outfits at 425	1,700.00
	$3,700.00
Interest on investment, 5 per cent.	$185.00
Depreciation on charging outfit, 10 per ct	170.00
Charging current	1,427.00
Salaries of charging attendants	2,400.00
Maintenance on 4,270 cells at $1.00	4,270.00
Proportion renewal of elements, estimated life, 8 years	2,668.75
Transportation of batteries, to and from charging station	1,200.00
Track battery (bluestone)	4,809.96
	$17,130.71
Cost for signal and indicator battery pr mile,	$21.92

FOR ELECTRIC MOTOR SIGNALS.

2 charging stations at $500	$1,000.00
2 charging outfits at 425	850.00
	$1,850.00
Interest on investment, 5 per cent.	$92.50
Depreciation on charging outfit	85.00
Charging current	697.32
Salaries of charging attendants	1,200.00
Maintenance on 2,104 cells	2,104.00
Proportion renewals of elements on 8 year basis	1,315.00
Transportation	600.00
Track battery (bluestone)	2,704.00
	$8,797.82
Cost, signal and indicator battery per mile,	$18.75.

Comparing the two batteries we find: For disk signals, primary $22.94; storage $21.92. For motor signals, primary $18.18; storage $18.75.

Mr. Rosenberg estimated for maintenance only, and made no allowance for the labor except at the charging plant, as he assumes that with any kind of power it will be necessary to employ battery men, as now, on account of the track batteries. Referring to Mr. Reynolds's statement concerning failures of signals due to failures of primary batteries Mr. Rosenberg said that in two years on his road there were 169 failures due to signal batteries, which is equal to only one failure in 260,748 operations.

Following Mr. Rosenberg Mr. Reynolds reaffirmed his opinion that no depreciation should be charged for the storage cells, but Mr. Elliott, and others, insisted that there was some breakage even with rubber jars; and Mr. Fritz agreed that it was proper to charge to maintenance, for this item, 12½ per cent. per year.

Mr. Yocum, being called upon, gave some details of the plant on the Reading, described by Mr. Reynolds. The power is bought by his department from the Motive Power department at 7½ mills per k.w. hour. Some of the members declared this an unreasonably low price, but others said that well-known electric companies sell power at even less than the rate named by Mr. Yocum. It was stated that in the power plant of the New York, New Haven & Hartford, at Berlin, Conn., the cost is 3 mills.

President Mock: Let us not lay too much emphasis on securing comparisons which must be based on equal conditions. What we ought to do at present is not to estimate the cost of a wholly new plant, but to see what we can do with our pumping engines and other power plants already established along our roads. . . . In this connection an officer of the Pennsylvania remarked that portable storage batteries would be at once economical on the New York division of that road, where signal bridges averaging eight arms each, occur at intervals of less than one mile. At present 32 cells of primary battery are used at each bridge. . . . A member remarked that the cost of primary batteries as given in the Southern Pacific example was much too high for the eastern part of the country.

Mr. Fritz, replying to a question, said that accumulators (with a charging line) sometimes would last only 18 months and in other cases 12 years and longer. For the first five years the only maintenance charge will be for the renewal of a very few defective cells and for the labor of putting in a little water occasionally. A chief advantage of the storage battery, he said, is its freedom from interruption by cold weather. Even at 10 deg. F. below zero a battery of 100 ampere hours capacity will give out at the rate of 40 ampere hours, and the only inconvenience is to charge more frequently.

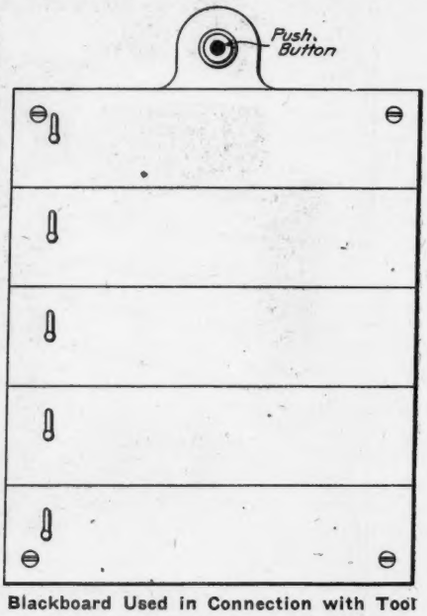
Mr. Balliet said that his experience with batteries at 32 deg. F. below zero confirmed this statement. With primary cells in cold weather it is often difficult to warm them by lamps as promptly as is desirable, but with the accumulators a little heat wakes them up. Mr. Leslie (Electric Storage Battery Company) replying to a question, said that frequent and incomplete charging of cells was not particularly injurious. He does not charge to the maximum capacity except once a week. The specific gravity is often a better guide than the voltage in charging, as it is a less variable index. Injury comes to batteries chiefly by excessive overcharging and by allowing them to stand fully discharged. The initial charge should be three times the capacity at the normal rate.

Mr. Anthony: The great essential with storage batteries is to train your men to obey the printed instructions to the minutest detail. So simple a matter as putting in the solution before connecting the charging wire would cause serious deterioration; correcting these small faults has resulted in perfectly satisfactory service.

The last hour of the meeting was spent in discussing paragraphs 14 to 29, inclusive, of the proposed standard specifications for mechanical interlocking material. This was in the nature of committee work and resulted in reporting a number of rules back to the committee; so that the whole of this part of the specifications will no doubt be rewritten. The annual volume of the Proceedings of the Association for 1904 has just been mailed to members.

Shop Messengers for Distributing Small Tools—Southern Railway.

A simple and effective system of tool distribution used in the shops of the Southern Railway is managed by means of blackboards placed throughout the shops. These boards are called tool stations. Each board is lined off horizontally and is fitted with a push button and hooks, as shown in the accompanying illustration. When a machinist wants a tool he goes to the tool station or board nearest to his machine and writes his name and



Blackboard Used in Connection with Tool Distribution—Southern Railway.

the tool wanted by him on the blackboard. He then hangs his check on the hook in a line with his name and presses the push button, which in turn operates an annunciator in the tool room and indicates the tool station from which the call came. A boy then answers the call by going to the blackboard and reading the instructions. He then takes the check to the tool room, secures the desired tool and delivers it to the machinist. This system prevents the men from wasting time and costs but little to maintain, as the boys who attend to the delivery of the tools are new apprentices and are put at this work as soon as they enter the shop, and are kept at it for about six months. It is found that this work not only familiarizes the boys with the different names and kinds of tools but that they also pick up considerable information that is of use to them when they are put to work at the machines.

Siam has a second railroad, extending from Bangkok west and south 94 miles to Petchaburi, on the Meklong River. It is of meter gage and has 29 stations. The other railroad extends 190 miles north from Bangkok.